An Exploratory Case Study Analysis of Implementation of Six Sigma in a New Zealand Organisation

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by

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Abstract

Since its inception at Motorola during the late 1980s Six Sigma has steadily risen in popularity and reputation as a worldwide standard for manufacturing quality through its objective of increasing quality through the decrease of variance. Six Sigma now boasts a wide variety of tools and processes that seek to improve quality, increase financial returns, improve customer satisfaction rates, reduce rework and waste. At its core Six Sigma follows the stepwise procedure of the DMAIC (Design, Measure, Analyse, Improve and Control) methodology.

This research sought to investigate and identify the success factors that are present during a Six Sigma project, for the reason that identifying and understanding these factors will provide practitioners with the knowledge to ensure that their Six Sigma Project has a higher chance of success. To achieve this a two stage approach was adopted. Stage One consisted of a systematic literature review of current and relevant literature in the Six Sigma and Business Improvement field. A systematic review was chosen for its ability to condense large amounts of information allowing the researcher to establish and recognise consistent information across sources of literature. Stage Two of this research consisted of an empirical analysis to identify success factors by conducting a single case study in an organisation applying Six Sigma through a series of semi-structured interviews. This approach is classified as an embedded single case design as it involves multiple units of analysis.

The framework applied to the Systematic Literature review was the Preferred Reporting Items of Systematic Reviews (PRISMA) and Meta-Analyses. This was to ensure a systematic and recordable process of literature search, exclusion and analysis. In Stage Two of the research, the semi-structured interviews (N=10) were transcribed then hand coded for analysis. Semi structured interviews were chosen for their capacity to allow the researcher to prepare questions in advance, while still allowing the conversation to flow naturally and in a relaxed setting. Subsequently the findings from both stages of the study were collated and compared. This provided a series of success factors which have both real world and literature evidence to corroborate and support their existence.

Success factors identified from the systematic literature review included the importance of project structure, efficient resource allocation, importance of accurate measurement systems, levels of knowledge/experience, levels of training provided to project members and the commitment level of senior managers and project members. Analysis of the semi-structured interviews provided real world evidence that substantiated the theories and claims uncovered during the systematic literature review.

The major finding from the analysis was the discovery of a success factor that was not described or discovered during the systematic literature review. This success factor is termed acceptance and refers to how the level employee ‘acceptance’ for Six Sigma projects had a strong effect on the success of the project.

To the extent of the researcher's knowledge this is the first investigation into success factors of a Six Sigma project within a New Zealand organisation/business. The findings from this study contribute to both the academic literature and managerial practices (i.e. operations management), by providing empirical evidence supporting theories surrounding project successes that were identified during the systematic literature review.

The findings suggest a series of success factors. These success factors are commitment of senior management, measurement accuracy, importance of project structure, knowledge/experience, resource allocation, and training for the employee's level. In addition to these success factors found in both the systematic literature review and in the interviews, there was a significant finding from the Case Study Organisation that was not found in the literature. This finding is new success factor - 'employee acceptance'. All of these success factors Business Improvement specialists can focus on and cultivate within their organisations, with the aim of increasing project success rates and, moreover, creating increased business growth.

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1. Introduction

This introductory chapter briefly introduces to Six Sigma, several of its key terms and a brief outline of what Six Sigma involves. It then gives the primary aims of the research as well as the Research Question combined with the specific aims of the systematic literature review that constitutes phase one of this two phase Masters inquiry. The research's contributions to practical and theoretical knowledge are then outlined. The chapter concludes by describing how the rest of the chapters are laid out and their components.

The Six Sigma quality management programme (also referred as simply Six Sigma) rose in popularity after it was developed at Motorola in 1987. The Six Sigma methodology was developed after it was found that the quality of goods being produced were below the standards that Motorola had set themselves. The Six Sigma systems and processes that we can find in organisations today have grown from the early Total Quality Management (TQM) practices. From these TQM practices Six Sigma has preserved the concept that everyone in an organisation is responsible for the quality of goods and services produced by the organisation. The original purpose of Six Sigma was to move the company's manufacturing process to a lower Defects per Million Opportunities (DPMO) level. The ultimate target was 3.4 DPMO. However, today Six Sigma has grown into a series of improvement concepts and tools that not only improve product quality, but also achieve quantifiable financial results, improve customer satisfaction rates and employee satisfaction (Akpolat, 2004).

1.1 Overview of Six Sigma

The core problem solving tool used within Six Sigma is known as DMAIC, which breaks down a specific project into structured phases that should be followed in order. DMAIC methodology is comprised of five sequential phases: Define, Measure, Analyse, Improve, and Control. This methodology guides the project team from the beginning of the project [Define] to maintaining the results [Control] (Zugelder, 2012). The projects themselves are identified, selected and prioritised based on the perceived and calculated importance to the organisation. (Arumugam, Antony & Kumar, 2013) Thinking that Six Sigma, especially the DMAIC methodology can be used throughout the entirety of the project we have to wonder how effective it actually is? Alternatively there is the possibility that the conditions surrounding the project itself play a more important role than we currently realise.

Six Sigma is built upon a tiered hierarchy based on experience known as the Six Sigma 'Belts'. The belt colours range from champion (also referred to as project sponsor), Green Belt, Black Belt and Master Black Belt. Each tier of Belts comes with its own varying levels of experience, training, responsibilities and objectives. (Akpolat, 2004; Gitlow & Levin, 2005).

Additionally, Six Sigma comes with a range of statistical tools, techniques, templates as well as management techniques ranging from leadership, conflict management, brainstorming, scheduling and decision making models (Barone & Franco, 2012).

Reviewing the background regarding Six Sigma research we can find case studies that focus on Six Sigma within an organisation as a whole (Timans, Ahaus, van Solingen, Kumar & Antony, 2016; Kumar & Antony, 2009; Albliwi, Antony, Arshed & Ghadge, 2017). Many of these studies note that "Six Sigma has evolved into a business strategy in many large organisations" (Antony, Kumar & Madu, 2005*)* and that the application of Six Sigma can be looked at as a data driven approach that seeks to identify and eliminate the defects and failures in a business process by improved focus on the process that is needed for the customer (Prasanna & Vinodh, 2013). However, what if we choose to look at Six Sigma from a different angle? Instead, the researcher will take a closer look at how Six Sigma can affect the organisation itself, with respect to the individual projects that organisations will undertake every single day.

1.2 Primary Aim of Research + Research Question

The literature on Six Sigma projects indicates that some are completed successfully (completed as per the plan with substantial benefits to the organisation) while others are not. This prompted me to ask "why"? Why are some projects successful and others are not? What organisational and project factors contributes to success or failure?

The primary aim of this study was therefore to investigate and identify if there are any identifiable factors that possibly lead to the success of a Six Sigma project. Amid the early stages of this research it was ascertained that there have been many studies into Six Sigma worldwide but there are only a select few articles and papers focusing on the application of Six Sigma within New Zealand. This observation gave rise to the secondary objective; to contribute to the collective academic knowledge that is identified by investigating one New Zealand organisation in order to examine in depth how a Case Study Organisation utilises Six Sigma in their day to day practices.

The study sought to answer the research question below (RQ) through two stages; a systematic literature review and a case study analysis at a single New Zealand organisation.

RQ: *How do contextual factors of a project account for Six Sigma project successes or failures?*

In order to ensure a comprehensive systematic literature review was conducted that covered a range of topics and delivered the data needed to answer this overarching research question five subordinate questions were proposed and ultimately answered. They were:

1. *What is Six Sigma?*
2. *When implemented effectively what gains does it give a business?*
3. *What does the literature say about the likelihood of successful implementation?*

4. *What evidence is there that Six Sigma has been implemented in New Zealand?*
5. *What is the level of reported successful implementation in New Zealand?*

1.3 Research Contributions

The knowledge gained from the completion of this research is expected to be beneficial for business practice as well as contribute to the current literature that addresses Six Sigma practices, project success and New Zealand business management practices.

1.3.1 Managerial Contributions

The outcome of this thesis produced a series of factors and/or business management practices that Six Sigma practicing managers should seek. By identifying a series of factors that business managers can focus on and foster within their environments this thesis offers managers a framework for achieving a higher degree of success in their Six Sigma projects, both in monetary terms and in non-tangible benefits.

1.3.2 Theoretical Contributions

As with the all research endeavours, this Masters study sought to contribute new understandings to the collective knowledge that has previously been published. The findings of this research continued this tradition by providing empirical evidence from a New Zealand organisation. At the time this research was completed, the numbers of academic studies focusing on Six Sigma in New Zealand was relatively small (Corbett, 2011; d'Young, Young, Ockelford, Brasser, Slavin, Manson, & Preston, 2014; Elias, 2016). However the specific success factors in New Zealand have not been investigated. Therefore, the overall aim of this research was to contribute to academic knowledge by providing empirical evidence of how a New Zealand organisation utilised Six Sigma in day to day practice. In doing so, the findings establish a foundation for future researchers when conducting similar research in New Zealand (and elsewhere).

1.4 Thesis Outline

Chapter Two consists of a breakdown on the methodology that was followed during the process of completing this research. Traditionally chapter two of any academic article would consist of a literature review surrounding the research question. However, for this research the systematic literature review was only one of two methods employed for data collection, so it was determined that in order for the document to be logical and flow naturally relevant literature would be placed in chapter three. The data collection for this research is primarily qualitative in nature and consists of a two-stage mixed methods study. Stage one consists of a systematic literature review surrounding Six Sigma. The PRISMA structure for systematic literature reviews was used. This was undertaken to ensure clarity and transparency throughout the review. Only data from journals that scored Scientific Journal Rankings (SJR) in the top quartile were used throughout the review. These journals comprised were Journal of Operations Management, Internal Journal of Production Economics and

the International Journal of Quality and Reliability Management. After all exclusions were made a total of 15 articles remained.

The second phase of this investigation consists of a single case (embedded[1]) design, taking the form of a series of semi structured interviews at a single large New Zealand manufacturing organisation. The case study organisation in question is an organisation that has utilised Six Sigma throughout their projects and everyday business processes for a significant period of time. Interview participants ranged from top level senior management, members of the Business Improvement team and Project Leaders. In total 11 separate candidates were interviewed, with a number of these candidates who spanned several roles throughout the organisation. This phase focussed on a random sample of 11 individual projects spanning a variety of driving factors and organisational departments.

Chapter Three consists of a systematic literature review focusing on Six Sigma project successes. This is phase one of data collection for this thesis. Several literature questions were crafted and ultimately answered. For this systematic literature review the PRISMA method and Meta- Analyses was applied for its effectiveness at ensuring clarity, critically appraising documents, ensuring transparency and reducing bias (Liberati et al., 2009).

The purpose of this systematic literature review was to gain an understanding of the current hypothesis and findings, allowing interview questions to be drafted and utilised in phase two of data collection.

Chapter Four contains details on the data collected from semi structured interviews. Within this chapter there is information regarding the demographics of the participants involved within the study. For privacy reasons no identities of interview participants have been published. Notes regarding the projects that were the focus point of this thesis together with results of the interviews are also included. These results have been hand coded from the interview transcripts for completeness when completing the results/discussion chapter.

Chapter Five presents the results of the semi structured interviews. These are displayed as the major categories/outcomes of the coded interview transcripts. Subsequently this chapter answers the research question: 'How do contextual factors of a project account for Six Sigma project successes and/or failure?' by showing clear connections between literature theory and data collected and new findings discovered from the case study organisation.

Chapter Six is the concluding chapter and contains a brief summary of the main findings from literature and evidence of literature theory regarding Six Sigma in a real world business setting. Additionally new findings have been reiterated which answers the research question using the

[1] Embedded- In an organizational study, the embedded units also might be "Process" units – such as meetings, roles, or locations (Yin, 1994, p.42).

culmination of findings from both the systematic literature review and case study organisation interviews. Moreover, contributions towards managerial usage and academic theory have been defined, limitations of the research are acknowledged and directions for future research are proposed.

1.5 Summary

This introductory chapter has provided a brief introduction to Six Sigma, including some of its key terms and how the hierarchy found within Six Sigma is structured. This chapter also states the primary objective of this study is to investigate the success factors that may contribute to Six Sigma projects success. The research question was stated; 'How do contextual factors of a project account for Six Sigma project successes and/or failure?' This chapter provided reasoning as to why this research thesis is important and the contributions that it will have on both academic theory and managerial practices. This chapter also provides a short breakdown of how the subsequent chapters are organised.

The next chapter is a systematic literature review. By using the PRISMA method it will answer the following questions:

1. *What is Six Sigma?*
2. *When implemented effectively what gains does it give a business?*
3. *What does the literature say about the likelihood of successful implementation?*
4. *What evidence is there that Six Sigma has been implemented in New Zealand?*
5. *What is the level of reported successful implementation in New Zealand?*

2. Methodology

The primary aim of this study was to investigate and identify if there are any distinguishable factors that possibly lead to the success of a Six Sigma project. The research question for this thesis was *'How do contextual factors of a project account for Six Sigma project successes or failures?'* This was achieved through the following methodology.

This research followed a two stage mixed methods process. The first stage consisted of a systematic literature review of relevant peer reviewed papers and the second stage involved a series of interviews at a New Zealand manufacturing company that utilises Six Sigma in almost every facet within their organisation. This two stage research approach was chosen to identify the extant literature on Six Sigma project success as well as to address the limited number of reported cases of Six Sigma implementation in New Zealand. The expectation was that the combination of a literature review that provided interview questions and an in-depth New Zealand case study would produce valuable insights into the factors that contribute to Six Sigma project success.

2.1 Stage One: Literature Review

The goal of a systematic literature review is to "provide a systematic, transparent means for gathering, synthesising and appraising the findings of studies on a particular topic or question. The aim is to minimise the bias associated with single studies and non-systematic reviews" (Jesson, Matheson & Lacey, 2011). The purpose in this case was to review research relating to Six Sigma project success and to generate a series of literature-based questions to guide the empirical phase of the research.

The key phases of a systematic literature review are as follows:

1. Phase One: Mapping the field.
    - What do we already know? What are we trying to learn? Create/define question or questions, compile key words. Decide on exclusion terms
2. Phase Two: Comprehensive search.
    - Access databases using key words. Search and document results. Check results, are they related? If not redefine search terms. Screen the title, abstract and if relevant, print or obtain the paper.
3. Phase Three: Quality Assessment:
    - Read full paper. Decide whether papers are IN or OUT of review. Document reasons for exclusion.
4. Phase Four: Data extraction:
    - Search and record relevant data
5. Phase Five: Synthesis

- Synthesise the data from individual articles into one. Show what we know and what we don't know. Is a meta-analysis or a mathematical synthesis feasible?

6. Phase Six: Write up:
    - Write up a balanced, impartial and comprehensive report, presenting the process reports will allow another researcher to replicate your review.

Adapted from: Jesson et al, 2011

2.1.1 Literature Research Questions

The literature questions that were drafted during phase one as part of the review process are:

- *What is Six Sigma?*
- *When implemented effectively what gains does it give a business?*
- *What does the literature say about the likelihood of successful implementation?*
- *What evidence is there that Six Sigma has been implemented in New Zealand?*
- *What is the level of reported successful implementation in New Zealand?*

2.1.2 Guiding Framework

The guiding framework that was used for this literature review was the PRISMA framework. What was originally known as the QUORAM (Quality of Reporting of Meta-Analyses) statement, first developed in 1999 by a group of internal collaborators in order to be utilised in the process of meta-analyses for randomly controlled trials. In 2009, this statement was amended and upgraded to include other practical and conceptual improvements. The name was eventually changed to PRISMA. Figure 2.1 shows the PRISMA Flowchart process from start to finish.

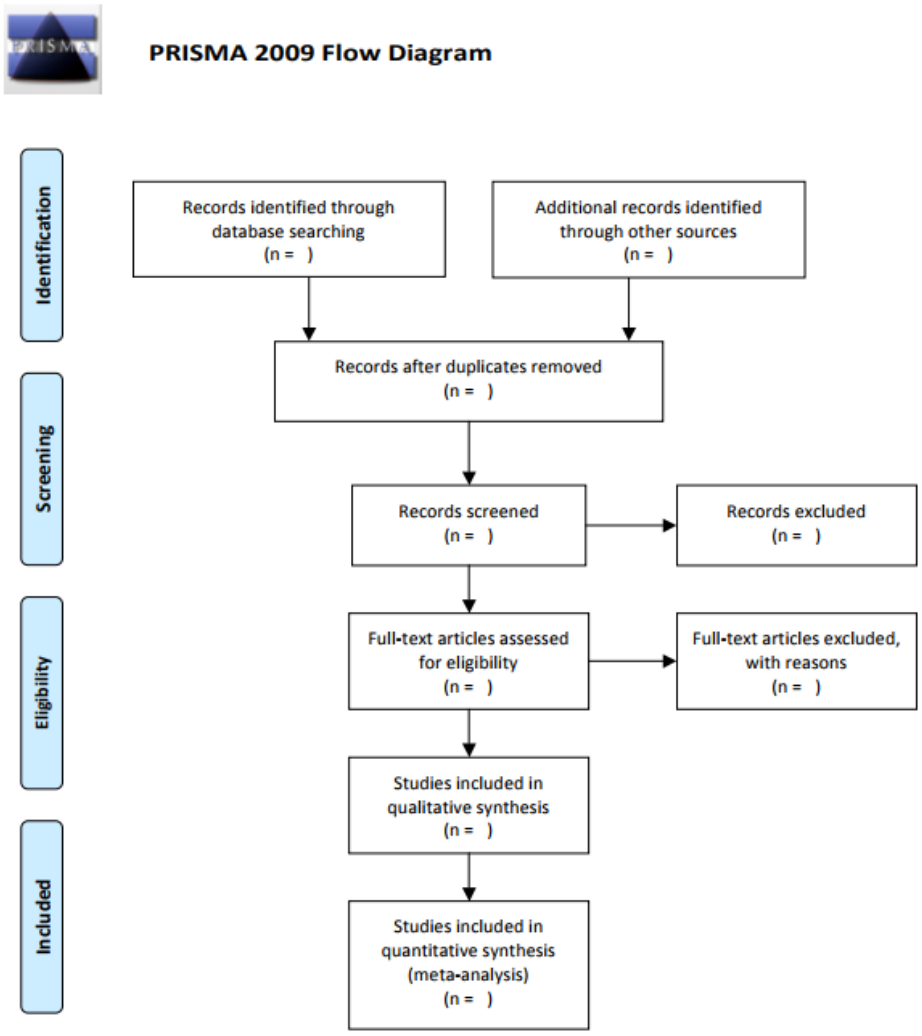


Figure 2.1 PRISMA Flow Diagram

Database

The database that was used for this research project was the University of Canterbury's Library Multi Search. The "Library databases provide access to a vast amount of material published in journals, newspapers, legal and other specialist collections" (D*atabases,* n.d.).

In particular this MultiSearch incorporates journals from Scopus, Google Scholar, University Database, ScienceDirect, Web of Science, Emerald Management E'journals database and countless others.

Search terms

Ensuring that the data discovered from the search would answer the literature question posed, thus it was important that the right search terms were used. The term 'Lean Six Sigma' was originally searched with no constraints, providing a total 2413 results. This search term was deemed far too impractical. The search term was then amended to include both 'Lean Six Sigma' and 'Project', with only results from 2000-2017 included. This returned a total of 445 results. This result was deemed still too large and once again exclusion constraints were placed upon the search to provide a manageable list specific to the research. These are as follows:

Year of Publication:

Originally this study placed no constraints concerning the year of publication, in order to compile and analyse as much literature data as possible. However, after returning so many results it was decided that some constraint should be put into place. For this reason only results from the past five years were included. As this research was completed in 2017, this meant that any results from before 2012 were excluded. Another positive aspect to this constraint was that this allowed the researcher to use time relevant material within the review as new literature is constantly being published that reinforces or disproves previous theories.

Document Identification

An exclusion constraint was put in place to ensure high quality research papers were used in this systematic review. This constraint consisted on only articles that scored in the top quartile rating from SCImago Journal and Country Rank. The SCImago takes its name from the SCImago Journal Rank (SJR) Indicator. In order for a Journal to be awarded a SJR ranking it first must be calculated through a process of three phases: (Guerrero-Bote & Moya-Anegon, 2012; Majstorovic, 2016).

- Phase One: Preliminary stage, A Journal is assigned the same default SJR. The final SJR is not awarded until the final phase as calculation is still required.
- Phase Two: iteration of previously administered default journal ranking. Computation is recurring, factoring in the number of citations in its particular field. The value calculated shows the journals rank based on its position with competing journals. For example a value of 0.8 represents 20 percent less prestige than the mean ranking for that particular subject area/category. A value of 1.3 represents 30 percent more prestige than the mean. This tells us that a SJR value of 20 is 20 times greater than the mean.
- Phase Three: calculation of SJRQ. This is calculated by dividing SJR by the number of articles in the journal, resulting in a prestige grade based on articles. This is done in order to balance out occurrences where journals may have a low publishing rate compared to others.

Once SJR and SJRQ have been calculated, the scores are then ranked accordingly. This list is then separated in quartiles within their own industry. For this research only papers found in the top quartile (Q1) were used.

These Journals were

- International Journal of Quality and Reliability Management,
- International Journal of Production Economics,
- International Journal of Operations and Production Management, and
- Journal of Operations Management

It was decided while Lean manufacturing and Six Sigma were often combined to create 'Lean Six Sigma.' using Lean Six Sigma as a search term would have selected articles that had 'Lean' in the title; such as Lean Manufacturing. For that reason 'Lean' on its own was redacted from the search and 'Six Sigma' was used instead. This would still provide the necessary results required for the review.

As for the majority of thesis and other postgraduate projects only peer-reviewed works were included within the study. This was deliberately done to ensure the quality of journals and papers that were collected.

Once these constraints were put in place the final search term was as follows:

(TitleCombined:(six sigma)) AND ((PublicationTitle:(journal of operations management)) OR (PublicationTitle:(international journal of production economics)) OR (PublicationTitle:(international journal of quality and reliability management))) NOT (lean)

Document Eligibility and Exclusion

The next stage in the PRISMA flowchart is screening. The sample was made up of 18 papers. The titles, abstracts and key words of these 18 papers were read through to determine if any were not applicable to this literature review. Those papers deemed applicable made mention of keywords such as Success, Project, Six Sigma, contextual factors relating to implementation of Six Sigma. In total two papers were screened and removed from the study. One paper was published in the Brazilian Journal of Operations Management. While similar to 'Journal of Operations Management' this article was not appropriate to the study as no SJR could be found. The final paper was excluded as a request for the full text was sent to the authors through Researchgate.net, however no response was returned.

The final stage of PRISMA flowchart is the full text articles are read then screened, while checking the eligibility of the papers. A thorough review was completed of all papers and only one article was excluded. It became apparent that while one article's abstract was written in English, the full text was

in Persian. Unfortunately the only language that the researcher is fluent in is English, thus providing valid reasoning for exclusion of this paper as there was no opportunity to translate the article into English.

This left a total of 15 articles eligible for review. An amended PRISMA Flowchart can be found at Figure 2.2

Note: No Meta-Analysis was performed in this review.

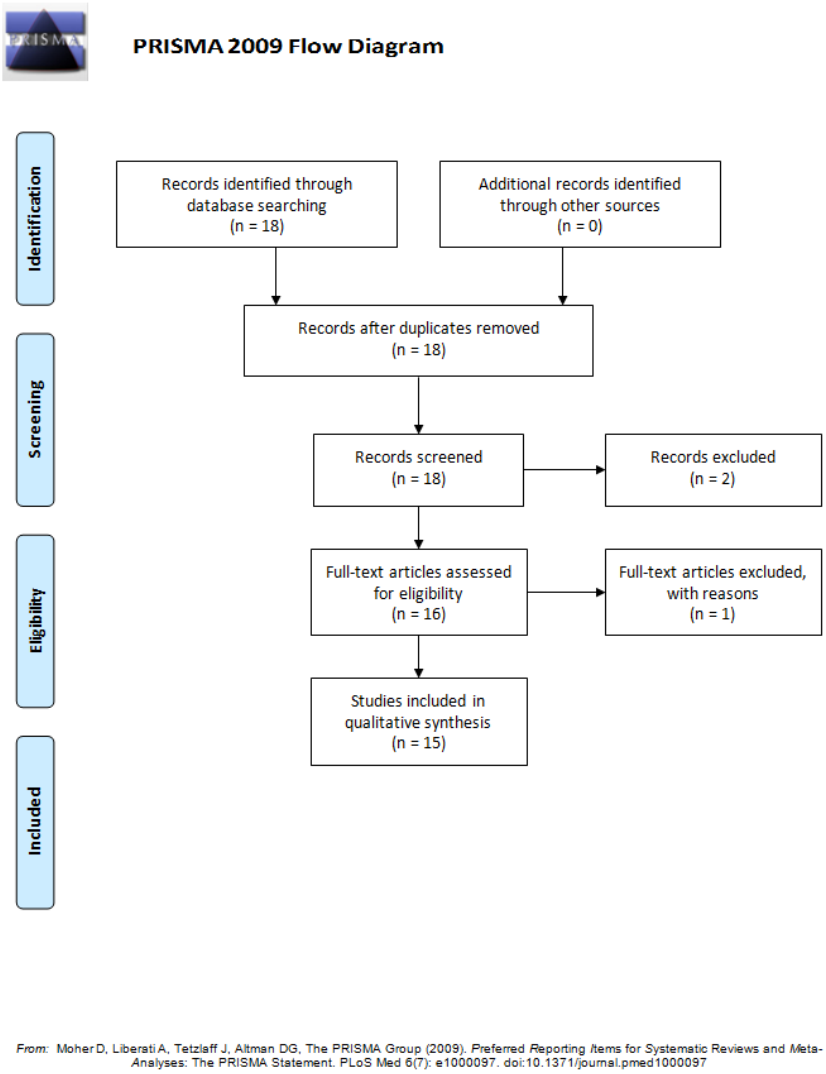


Figure 2.2: PRISMA Flowchart amended to show methodology used in Stage One.

2.2 Stage Two

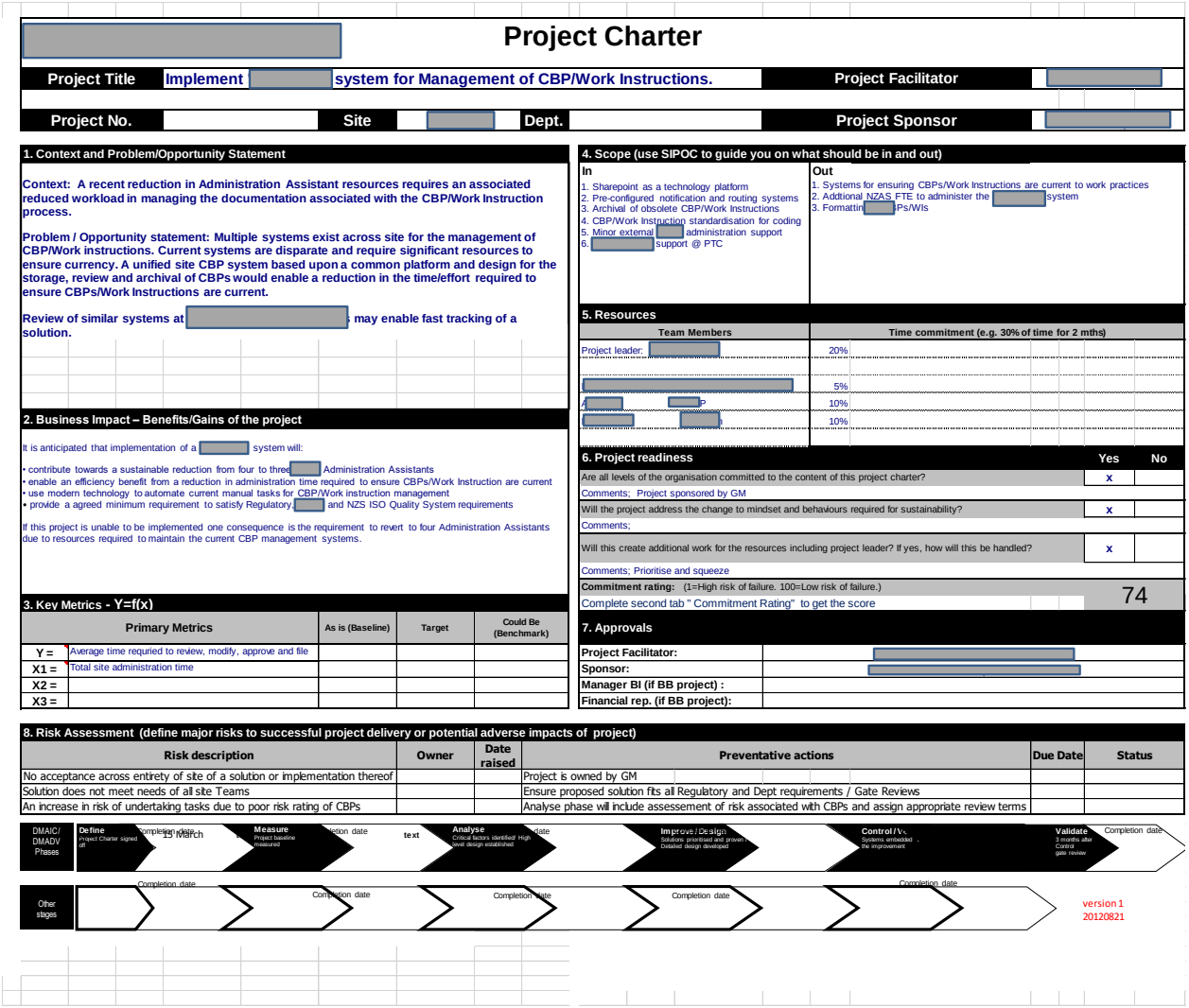
The second stage of this mixed methods research study contains a series of semi-structured interviews. These interviews took place at a single Case Study Organisation location making them an embedded single case design as they involved multiple units of analysis (Yin, 2014, pp. 50). These units of analysis comprised of a total 11 projects ranging across business departments and various drivers of success.

"A case study allows investigators to focus on a case and retain a holistic and real world perspective such as studying individual life cycles, small group behaviour, organisational and managerial processes, neighbourhood change, school performance, international relations and the maturation of industries. (Yin, 2014, pp. 4). As this research paper is focusing on managerial and operational processes, a case study is a valid method to collect data for this situation.

The strengths of semi structured interviews stems from the structure that can be formed and followed throughout the process. The development of a set of specific questions, selection of respondents and the audio taping of the interview, where during the interviews a rapport can be formed with both parties. This helps ease tension and hopefully provides an experience that offers a higher degree of 'Richness' of data as compared to surveys or observational note taking (Warren & Karner, 2010).

Interviews are frequently found in case research, and often these interviews resemble guided conversations rather than being more structured and controlled. These are often referred to as 'intensive interview, semi structured or unstructured interviews' (Yin, 2014). This research followed this line particular line of questioning. A series of starter questions were drafted from the literature analysed in Stage One. These questions were used to initiate conversational flow while selected prompts were used to continue the line of questioning. These questions are appended as Appendix 1.

While interviews are a very effective way of collecting data, it is recognised that it is a verbal account. People have a tendency to have bias, poor recall, or articulation of their thoughts (Yin, 2014). For this reason the 'Project A3's' were also analysed to support the data collected from interviews. The 'Project A3' charters are simply documents containing project context, problem/opportunity statement, business impact (benefits), scope, resources required and a timeline of project. An example A3 provided by the Case Study organisation can be found in Figure 2.3



Project Charter

Project Title	Implement [redacted] system for Management of CBP/Work Instructions.	Project Facilitator	[redacted]
Project No.		Site	[redacted]
Dept.		Project Sponsor	[redacted]

1. Context and Problem/Opportunity Statement

Context: A recent reduction in Administration Assistant resources requires an associated reduced workload in managing the documentation associated with the CBP/Work Instruction process.

Problem / Opportunity statement: Multiple systems exist across site for the management of CBP/Work instructions. Current systems are disparate and require significant resources to ensure currency. A unified site CBP system based upon a common platform and design for the storage, review and archival of CBPs would enable a reduction in the time/effort required to ensure CBPs/Work Instructions are current.

Review of similar systems at [redacted] may enable fast tracking of a solution.

2. Business Impact – Benefits/Gains of the project

It is anticipated that implementation of a [redacted] system will:

- contribute towards a sustainable reduction from four to three [redacted] Administration Assistants
- enable an efficiency benefit from a reduction in administration time required to ensure CBPs/Work Instruction are current
- use modern technology to automate current manual tasks for CBP/Work instruction management
- provide a agreed minimum requirement to satisfy Regulatory [redacted] and NZS ISO Quality System requirements

If this project is unable to be implemented one consequence is the requirement to revert to four Administration Assistants due to resources required to maintain the current CBP management systems.

3. Key Metrics - Y=f(x)

	Primary Metrics	As is (Baseline)	Target	Could Be (Benchmark)
Y =	Average time requried to review, modify, approve and file			
X1 =	Total site administration time			
X2 =				
X3 =				

4. Scope (use SIPOC to guide you on what should be in and out)

In	Out
1. Sharepoint as a technology platform 2. Pre-configured notification and routing systems 3. Archival of obsolete CBP/Work Instructions 4. CBP/Work Instruction standardisation for coding 5. Minor external [redacted] administration support 6. [redacted] support @ PTC	1. Systems for ensuring CBPs/Work Instructions are current to work practices 2. Addtional NZAS FTE to administer the [redacted] system 3. Formattin[redacted]Ps/WIs

5. Resources

Team Members	Time commitment (e.g. 30% of time for 2 mths)
Project leader: [redacted]	20%
[redacted]	5%
[redacted]	10%
[redacted]	10%

6. Project readiness

	Yes	No
Are all levels of the organisation committed to the content of this project charter?	x	
Comments; Project sponsored by GM		
Will the project address the change to mindset and behaviours required for sustainability?	x	
Comments;		
Will this create additional work for the resources including project leader? If yes, how will this be handled?	x	
Comments; Prioritise and squeeze		
Commitment rating: (1=High risk of failure. 100=Low risk of failure.)		74
Complete second tab " Commitment Rating" to get the score		

7. Approvals

Project Facilitator:	[redacted]
Sponsor:	[redacted]
Manager BI (if BB project) :	
Financial rep. (if BB project):	

8. Risk Assessment (define major risks to successful project delivery or potential adverse impacts of project)

Risk description	Owner	Date raised	Preventative actions	Due Date	Status
No acceptance across entirety of site of a solution or implementation thereof			Project is owned by GM		
Solution does not meet needs of all site Teams			Ensure proposed solution fits all Regulatory and Dept requirements / Gate Reviews		
An increase in risk of undertaking tasks due to poor risk rating of CBPs			Analyse phase will include assessement of risk associated with CBPs and assign appropriate review terms		

Figure 2.3 Redacted A3 Charter. Provided by Case Study Organisation.

2.2.1 Case Study Organisation

The case study organisation that was chosen for this study is a very large New Zealand manufacturing organisation. They export 90 percent of their products produced to Europe, USA, Japan and other Asian countries. These sales are worth approximately NZ$1billion per financial year. They have approximately 800 fulltime employees.

2.2.2 Interviewees/Projects.

As the interviewees would be discussing about projects and their thoughts regarding their participation, the interviews were kept anonymous. In order for this goal to be achieved the researcher was permitted access by the organisation to their site 'project hopper' which contained past, present and future improvement projects. This freedom allowed random selection of projects which the researcher believed would yield informative results on the success or failure of a project. For example, the projects selected were spread across different Departments, a range of project time

lengths, perceived value/benefit of a successful project and also varying driving factors behind the projects.

Before the interview commenced each participant was emailed an information sheet detailing the purpose of the interview, several questions that would be asked and were informed of their rights of disclosure as an interviewee. Additionally, before any questions were asked and before any audio recording began the interview participants also signed a consent form acknowledging that they have read and understood the information sheet and consented to participate in the interview.

Sometimes when completing research, anonymity is necessary, most commonly when dealing with a controversial topic. It is the anonymity that protects the participants involved and their views on the matter (Yin, 2014). Because this study will involve participants making their thoughts on projects made public, the researcher decided that in order to maintain anonymity all mention of interviewees would be nameless. Should someone speak negatively regarding a project or process there would be no manner in which their thoughts would be traceable back to them. In addition to this, the projects themselves are referred to by number in which they were investigated, driving factor i.e. financial, health and safety, process efficiency, perceived value to the business etc.

2.2.3 Recording of Interview

It is common practice for interview research to use recordings as a means of collecting data. Those involved with the interview must be made aware and agreed to the conditions surrounding recording and the method of recording [in this case digital voice recorder] should remain in plain sight at all times. The respondent should be made aware of their rights with regards to being recorded in that at any time they want the recording turned off they only have to say so, and that they can close the interview down at any moment of their wishing (Warren & Karner, 2010). To aid with analysis of the data, all interviews were audio recorded using a voice recorder for accurate, high quality recordings. As stated within the agreement, both with the Participant and the University of Canterbury, the interviewee had prior knowledge that the session was to be recorded. This was achieved through the prior email containing an information sheet and consent form outlining their rights within the interview room and the topic/projects the researcher would be enquiring about.

2.2.4 Transcribing

Transcribing recordings is a relatively simple but time consuming process. However, the benefits are monumental. Not only is the researcher able to produce a record of what was said should any issues or complaints arrive, the transcript allows the participant in the interview to review and omit any statements made that they do not wish to be in the study. A transcription also assists in the analysis phase of a research as the information is in a physical form and can be coded and broken down with relative ease (Richards, 2015). The researcher transcribed all interviews himself, simply into a Microsoft Word file. While this can be time consuming it also provides the benefit of re-hearing the

interview, and noticing moments previously missed and the researcher can begin to recognise common phrasings and themes.

2.2.5 Coding

Coding within qualitative research and literature most commonly produces a word or series of words that shorten, summarise, or conceptualise a portion of language-based or visual data. The coding method provides the researcher with the ability to organise and group coded data that are similar in themes/ideas into categories or groups for further in-depth analysis, (Saldaña, 2009). One of the initial steps in a coding process is known as 'open coding'. Open coding at this point is basically identifying whatever appears significant in the data. Margin notes are used, sentences or relevant paragraphs are highlighted and comments or thoughts from the researcher are made note of (Richards, 2015; Warren & Karner, 2010).

The next step in analysing data is to narrow the focus by attending to what is actually being said and what it means, rather than just what is on the surface. According to Richards (2015) and Warren (2010) there are three possible techniques to achieve this:

1. Topic Coding: A phrase meaning coding that allocates passages to topics. Usually simple phrases '*this paragraph is about project 1, this is about collecting data.'* This is not a very in depth method and takes a relatively short period of time.
2. Descriptive Coding: Information that describes a case. This looks at the attributes of the topic in question. For example, a persons' gender, business size, start and finish dates. While all this is useful information it does not look deeply into the information.
3. Analytical Coding: The third and final technique has been referred to as analytical coding, however it is generally a combination of the two previous coding methods with extra information attached. This method of analyses leads to theory emergence and theory affirmation. Researchers must ask themselves additional questions such as '*What is this passage about?'; 'Why is it interesting?'; 'I wonder what else that applies* to this?' Additionally, it provides the necessary ground work to enable analysis to be linked to concepts derived from literature.

2.2.6 Analysis

An inductive analytic method was chosen primarily because this is a mixed method study (i.e., a Systematic Literature Review plus Case Study Interviews) and the analytic method needed to take into account the conclusions drawn from the literature review and examine them in relation to data gathered from a real world case study. Additionally, the analysis needed to take into account that the interview data contained both descriptive information about the way Six Sigma was being implemented (project attributes) and the interviewees' thoughts on the Six Sigma approach and how it was implemented.

Analysis of the interview transcriptions was completed using manual coding. Manual coding is an extremely simple and streamlined process. Often this will involve printing out interview transcripts and utilising this opportunity to write on the data, noting down thoughts regarding the data as soon as they manifest. It grants the researcher a feeling of control and ownership over the data (Saldaña, 2009). That is not always so easy to achieve when using sophisticated software packages like NVIVO. While the researcher acknowledges such electronic methods of coding are available, the ability to manually lay the data out and see the 'fuller' picture was exceptionally valuable in this study. This became particularly useful when dealing with longer transcripts that involved many pages.

Analysis of the coded transcripts was a relatively straight-forward process. All transcripts were read through and then coded using the analytical method. No matter whether a section of transcripted text contained a new idea or repeated an idea or interpretation, it was promptly coded into an existing category or a new category was made if an appropriate category did not exist. Each excerpt was coded, complete with notes designed to support future avenues of thinking. Once these notes started to build up it became apparent that a more in-depth approach was required. Questions relating to the content of the notes were generated. Questions such as 'Have I seen evidence of this in the literature that was systematically reviewed?', 'How does this relate to the research question?', 'Why did this stand out in the transcript?', 'What conditions existed in this project that are different from those in others?', and 'What are the repeating themes?' were used to explore the data further.

The conclusions drawn from this in-depth analysis provided the basis for the results and discussion found in Chapter Five.

2.3 Ethical Considerations

As per University of Canterbury's policies, a Human Ethics Application was submitted to the Universities Human Ethics Community outlining the proposed methods of data collection and the considerations therein. This application was approved.

As outlined in the Ethics Application, all interview participants were aware of what their participation involved and their rights as a result of the explanations provided in the information sheet each received. They acknowledged their understanding and willingness to participate by signing a consent form. Their interviews were audio recorded, transcribed and then manually coded for analysis by the researcher, using coded names and pseudonyms where appropriate to ensure confidentiality for both the company and the participants.

2.4 Summary

The purpose of this chapter was to outline the methodology followed throughout study and to show the reasons why such method was judged as appropriate for this research project. The chapter began by explaining that the method was a two stage process. Stage One consisted of a systematic literature review of the relevant academic literature. Utilising the PRISMA method, five literature questions were answered; What is Six Sigma?, When implemented effectively what gains does it give a business?, What does the literature say about the likelihood of successful implementation?, What evidence is there that Six Sigma has been implemented in New Zealand?, and What is the level of reported successful implementation in New Zealand?

The chapter then described Stage Two of the methodology. This stage consisted of one Case Study Organisation in New Zealand and involved semi-structured interviews of senior management responsible for Six Sigma implementation, Project Leaders and Team Members for a range of projects.

The next chapter in this thesis is a systematic literature review. By using the PRISMA method it will answer the following questions:

1. *What is Six Sigma?*
2. *When implemented effectively what gains does it give a business?*
3. *What does the literature say about the likelihood of successful implementation?*
4. *What evidence is there that Six Sigma has been implemented in New Zealand?*
5. *What is the level of reported successful implementation in New Zealand?*

3. Literature Review

The purpose of this literature review chapter is to document the theories located and the conclusions drawn regarding Six Sigma and factors influencing project success during the review process. Five questions guided the Systematic Review Process. These five questions are:

1. *What is Six Sigma?*
2. *When implemented effectively what gains does it give a business?*
3. *What does the literature say about the likelihood of successful implementation?*
4. *What evidence is there that Six Sigma has been implemented in New Zealand?*
5. *What is the level of reported successful implementation in New Zealand?*

The layout for this chapter follows this sequence of questions. It answers each of these questions in before providing a summary of the findings and briefly outlining the content of chapter four.

3.1 What is Six Sigma?

3.1.1 History

Society today is experiencing escalating competition due to globalisation and the opportunities that the Internet has provided for more rapid information exchange. This increased competition forces organisations to adapt in order to survive in the modern market place. Organisations are increasingly required to produce goods and services to a higher quality or for a cheaper rate in order to increase customer satisfaction and loyalty and sustain business growth. Businesses must find ways to recognise the ever changing needs and wants of the customer and then change/improve their business processes in response (Choi, Kim, Leem, Lee, & Hong, 2012; Joghee, 2017; Saghaei, Najafi & Noorossana, 2012).

Six Sigma itself originated in the late 1980s, after being envisioned by engineers at Motorola Inc. Six Sigma was originally designed as a means of measuring defects and improving quality through various metric approaches. Linderman, (as cited in Sony, 2012) defines Six Sigma as "an organized and systematic method for strategic process improvement and new product and service development that relies on statistical methods and the scientific method to make dramatic reductions in customer defined defect rates." Using a 'sigma level' (σ) as a "goal of improving processes by reducing customer-defined defect levels to below 3.4 defects per million opportunities" (Easton & Rosenzweig, 2012).

Also, Six Sigma is sometimes referred to as Lean Six Sigma primarily because Lean Six Sigma is a combination of Lean manufacturing and Six Sigma. Combining the benefits of both initiatives provides more opportunities and value for an organisation that has implemented a well-run and effective Lean Six Sigma program.

Lean manufacturing is a systematic method of manufacturing that focuses primarily on the reduction of waste all the while producing at the lowest possible cost and at a fast pace (Bhamu & Singh Sangwan, 2014; Shah & Ward, 2003). According to Patidar, Soni and Soni (2017) these forms of waste are:

- Unnecessary transportation
    - Transportation of goods that do not provide any immediate value to the Organisation
- Inventory
    - Having high inventory numbers leads to increased storage costs.
- Waiting
    - Reducing the amount of machines that are idle and not producing value.
- Overproduction
    - Producing a higher number of goods/components than required.
- Excessive processing
    - Extra work that is required. For example poorly set up machines that need re-calibrating
- Unnecessary movement
    - Resources such as machines and rather than people producing value for the organisation
- Quality defects/rework
    - Defects lead to increased costs and resources to fix to appropriate standard.

While Six Sigma tends to rely heavily on statistical analysis and quantifiable data, Lean Manufacturing tends to lean towards a more knowledge based approach. This approach relies more on knowledge and experience than statistical methods (Antony, Snee & Hoerl, 2017).

While Six Sigma has its DMAIC methodology, Lean manufacturing has its own methodology. An organisation enforcing Lean manufacturing will follow five separate phases. According to Andersson et al. (2014) these five phases are:

- Understanding Customer value.
    - That is, focusing on what the customer perceives as value for a product/service
- Value Stream analysis
    - Looking at internal processes to determine which ones provide value to the organisation. If a process is deemed not to provide value it must be removed or improved until it does.
- Flow:
    - Reduce queue time within processes. Focus on the flow of goods being produced, with importance on continuous, uninterrupted flow of production.

- Pull:
    - Ensure production is a pull system rather than a push system. For example producing goods only when the demand arises. This demand pulls the item down the value chain, rather than over producing products, leading to warehouse and storage costs.
- Perfection:
    - Perfection within a process is difficult for an organisation to achieve. Instead it is a matter of continuous improvement. There is no obligation to complete these five phases in consecutive order, but rather when the need arises to reach the goal of continuous improvement.

As mentioned Lean manufacturing comes with a variety of techniques and tools that is not part of Six Sigma's repertoire. Bhamu & Singh Sangwan (2014) list the following techniques that are included within the Lean manufacturing framework.

- J.I.T Manufacturing
    - Just in time manufacturing. Used with the aim of reducing production flow times. Only manufacture goods when demand 'pulls' them down the value chain.
- 5S-
    - Used to organise a workplace to increase efficiency. 5S is comprised of Seiri (sort), Seiton (Set in order), Seiso (Shine/sweeping), Seiketsu (Standardise), and Shitsuke (Sustain).
- Kanban-
    - Scheduling system used in manufacturing workplaces. Used in conjunction with JIT manufacturing.
- TQM-
    - Total Quality Management. Primarily based around long term success through customer satisfaction and continuous improvement.
- Kaizen
    - Kaizen is built on the foundation of continuous small words missing. Put full stop at end.

However this research focuses primarily on standalone Six Sigma projects.

Six Sigma has grown into a useful management philosophy and problem solving method for organisations that are involved with process improvement projects, as they seek to expand their operations. Six Sigma methodology provides the tools to identify select and prioritise projects based on strategic importance to organisations, whether that importance be internal goals such as decreasing wait times, or increasing cash flow and growth (Arumugam, Antony & Kumar, 2013; Choi et al., 2012). These improvement tools are the driving factor behind improving organisational performance

(Easton, 2012), providing workable ideas and solutions allowing the organisation to grow and compete in whatever market they operate in.

Researchers describe Six Sigma as a data driven approach to problem solving, and as a management strategy, a quality/process improvement methodology incorporating quantitative analysis to make dramatic measureable improvements within an organisation (Swink & Jacobs, 2012). However, this statistical approach towards management also begins to put forward the issue of accurate measurements when relying solely on numerical data. Joghee (2017) outlines the importance of accurate measurement data as "early detection of signals and/or sustaining a process close to the target by means of reducing process variation will result in high-quality processes and products and is, in fact, the major goal of a Six Sigma program of any organisation." This theory is reinforced by Cox et al., (2016) as "the ability of a measuring device to provide consistent measurement data is important in the improvement of any process" and in that Six Sigma management activities emphasize the importance of measurement (Choi et al., 2012). As this is apparently a common theory that measurement is a vital part of a projects process, this research seeks to see determine if there are other factors that contribute to a projects success and to ascertain if there is empirical evidence that is consistent with academic literature.

All organisations go through change, either growing and becoming more successful or decreasing in value. Now this could occur naturally through market growth or it could be a result of the organisation making strategic decisions in order to itself. Therefore organisations will undertake projects that are aimed at creating value for themselves. Throughout an organisation's life cycle it will undoubtedly undertake many projects, not necessarily projects on a scale worth millions of dollars or high level corporate mergers, but small projects such from hiring new employees to purchasing new cleaning supplies. Each project has the potential to fail, some just more spectacularly than others due to the monetary or business process consequences. As with any project, team members may be sought from different departments within the organisation. The same analogy can be found within a Six Sigma project team. Drafting team members from within all reaches of the organisation allows for different levels of knowledge and experience to be shared and utilised to the greatest extent. This usage of different knowledge streams facilitates the flow of information and team knowledge to a higher degree across departmental boundaries. The knowledge of the individual is collected and then converted into team knowledge. It is this collective knowledge that allows teams to work on projects outside their direct departments within an organisation even though some team members may not have detailed familiarity with the business process outside their specific work team. Thus, the team make up of any Six Sigma project team is like any other. They are often temporary, and have been formed for one specific process or goal in mind. They often have a short duration, i.e. three to six months and with the exception of the project leader, team members will often only contribute a fraction of their time towards the project (Arumugam et al., 2013).

3.1.2 Six Sigma Tools

Six Sigma is no longer purely just about reaching a sigma level of 3.4 defects per million opportunities. While some argue that Six Sigma is just a repackaging of Total Quality Management (TQM) and that the only extra aspect it puts forward is that it provides more justification (Sony & Naik, 2012), there have been investigations that are differing in the fact that Six Sigma provides a more structured, and well defined approach through its use of a 'Belt' system in determining roles and what is known as the structured 'DMAIC methodology'. For example, Six Sigma can also be used as a way of reducing wastages such as resources and time and by listening and connecting the customer wants and needs with the process objectives (Sony & Naik, 2012). Six Sigma achieves this through its usage of various statistical and managerial tools. These include what is known as the DMAIC methodology, analysis of collected data, control charts/Statistical Process Control (SPC), Design of Experiments (DOE), cause and effect diagrams, brainstorming, data mining, 'five whys' and exploratory data analysis (Cox et al., 2016; De Mast & Lokkerbol, 2012; Joghee, 2017).

Table 3.1 provides details of the phases where the Six Sigma tools are appropriate.

Tool name	Phase of DMAIC in which tool is most commonly used.				
	D	M	A	I	C
Affinity Diagram	•		•		
Business case	•				
Cause-and-Effect diagrams			•		
Chater	•				
Contol charts		•	•	•	•
CTQ (Critical-to-quality) Tree	•				
Data Collection Forms		•	•	•	•
Data collection plan		•	•	•	•
Design of experiments			•	•	
Flow diagrams	•	•	•	•	•
Frequency Plots		•	•	•	•
FMEA (Failure Mode and Effect Analysis		•		•	
Hypothesis tests			•		
Pareto Charts		•	•	•	
Process Capability		•		•	
Quality Control Process Chart					•
Regression			•		
Rolled Throughput Yield	•				
Sampling		•	•	•	•
Scatter Plots			•		
SIPOC	•				
Stakeholder analysis	•			•	
Time Series Plots (Run Charts)		•			
VOC (Voice of the customer)	•				

Table 3.1: Six Sigma tools and the appropriate phase they should be applied to. Adapted from Rath and Strong, n.d.

The DMAIC methodology consists of five phases. Define, Measure, Analyse, Improve and Control (Easton 2012; De Mast & Lokkerbol, 2012; Mehrjerdi, 2013; Swink & Jacobs 2012) and "is similar in function as its predecessors in manufacturing problem solving, such as plan-do-check-act" (De Mast & Lokkerbol, 2012).

Thus the core Six Sigma template for problem solving is known as 'DMAIC' and this has become an invaluable tool for organisations. The DMAIC methodology is a template for how a project can be structured, providing a systematic stepwise procedure that is a collection of techniques and analysis tools. One of the successes of the DMAIC template is that it "provides an excellent framework for thinking about a problem in a linear way, where a team will finish one phase and then smoothly and easily coast into the next" (Shanmugaraja, Nataraj & Gunasekaran, 2012).

Table 3.2: Depicts the typical phase by phase routine that an organisation utilising Six Sigma and the DMAIC methodology would follow. One present-day issue with the DMAIC methodology is that researchers and practitioners have the belief that "DMAIC is applicable to empirical problems ranging from well-structured to semi-structured, not to ill-structured problems or pluralistic messes of subjective problems." (De Mast & Lokkerbol, 2012).
This is saying that DMAIC may not be the most efficient and effective method for projects that deal with high levels of a person's emotions, beliefs and/or personal opinions. It would be more suited to projects that require statistical analyses, problem solving and other quantifiable data. Additionally DMAIC has been theorised to be suitable for more general, everyday routine projects. Projects that seek to improve routine problems (De Mast & Lokkerbol, 2012), labour intensive repeatable projects, (Swink & Jacobs, 2012) in theory can use the DMAIC process as a step by step checklist.

Statistical control charts (SPC), also known as control charts, are popular control charts used for monitoring the quality of processes and products. The aim of a SPC chart is to improve quality through identification and then monitoring variation within a process (Chen & Liang, 2016). Control charts will, if used correctly, detect when a process has fallen out of control, allowing the user to delve deeper into the particular moment in time when the process was 'out of control' to attempt to find a source for the issues (Joghee, 2017), Figure 3.1 shows a typical control chart with points in and out of control. Any data points that fall outside the upper control limit (UCL) or lower control limit (LCL) that have not been characterised as outliers are deemed out of control.

DMAIC Phase	Objective	Actions
Define	Problem selection and benefit analysis	Identify relevant processes, stakeholders, customer needs and complete business case.
Measure	Translation of the problem into a measurable form, and measurement of the current situation. Redefine objectives if needed	Select CTQ's (Critical to Quality characteristics), determine requirements for CTQ's Validate measurement systems, assess current process capability, and define objectives.
Analyse	Identification of influence factors and causes that determine the CTQ's behaviour.	Identify potential influence factors and select the 'vital few'.
Improve	Design and implementation of adjustments to the process to improve the performance of the CTQ's.	Quantify relationships between X's and CTQ's Design actions to modify/improve processes involved to optimise/improve CTQ's.
Control	Empirical verification of the projects results and adjustments of the process management and control system in order that improvements are sustainable.	Determine new process capability, implement control plans

Table 3.2: Detailed DMAIC Breakdown. Adapted from De Mast & Lokkerbol, (2012)

When a point is identified as being out of control this indicates that there has been a change in the process mean or standard deviation and the situation needs to be addressed and investigated. With any statistical analysis the knowledge that the measuring device in use provides reliable, consistent and accurate measurement data is important to the improvement of any process and to the organisation as a whole. (Choi et al., 2012; Cox et al., 2016). See the second table (R Chart) noted with a '1' is a point where the range has been identified as out of control as it is at/above the UCL.

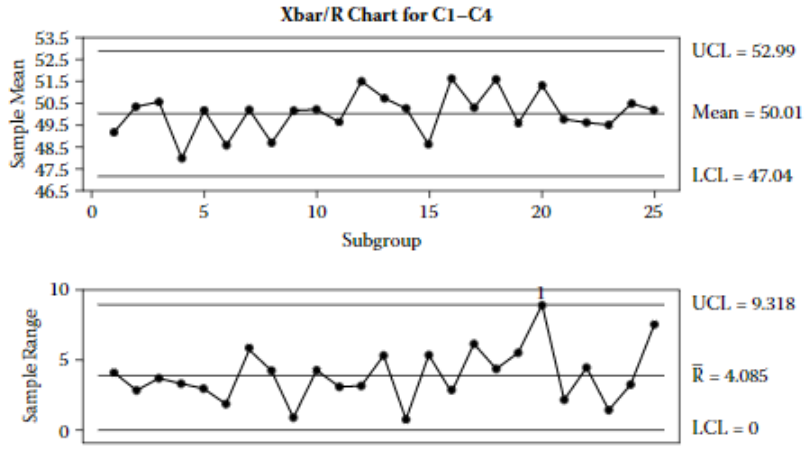


Figure 3.1: X Bar/ R Chart showing out of specification data point. (Levinson, 2011).

3.1.3 Belts

Six Sigma operates using a tiered qualification policy known as 'Belts'. These belts are colour coded to signify what rank/tier the employee has reached. They signify different levels of qualifications gained through training and projects worked on. The colours range accordingly; yellow, green, black and master black. (Choi et al., 2012; Shafer & Moeller, 2012). Much like in martial arts these belts are earned after a period of training and practice. Typically Green Belts receive two weeks of training, while Black Belts are more extensively trained having completed four weeks of training **(**Peterka, 2008). As Black belts are more extensively trained they usually are responsible for higher value projects, those that are high risk, high reward; Green Belts traditionally receive basic Six Sigma training and tend to serve as project leaders in conjunction with a Black Belt. Those with Green Belts are normally assigned lesser value projects as they have not received the level of training as a Black Belt. Yellow Belts have limited training to identify when opportunities for Six Sigma improvement can be applied, or otherwise undertake testing under the supervision of a Green of Black Belt.

Thornley Group Consulting and Training is an organisation with offices in New Zealand and Australia that provide business consultancy services. Additionally they also provide training courses for Six Sigma Green and Black Belts. Table 3.3 has been created from information on their website (*Lean-Six-Sigma-Training-Courses, n.d.)* outlining the contents of each course.

Green Belt Training Course	Black Belt Training Course (In addition to Green Belt)
Introduction to Lean Six Sigma and the DMAIC Project Process	Managing Change
Establishing Projects	Leadership
Forming Teams	Value Stream Analysis
Developing Project Team Charters	Lead-Time Reduction
Basic Project Management	Flexible Production
Mapping the process	Levelling Demand
Customer Requirements	Line Balancing
Base-lining	Standardised Work
Variation and the Normal Distribution	Kaizen and Kaizen Blitz
Collecting Data	Critical to x
MSA	Benchmarking
Graphical Analysis	Balanced Scorecard
Process Capability	Cost Benefit Analysis
FMEA	Managing Teams
Identifying, organising and verifying Causes	QFD
Hypothesis Testing	Kano Model
Regression Analysis	Metrology
Introduction to Design of Experiments	Advanced Statistical Concepts
Creating Solutions	Probability Distributions
Selecting and Promoting Solutions	Attribute Data Analysis
Piloting	Contingency Tables
Implementing Solutions	Advanced Hypothesis Testing
Using Lean Methods	Design of Experiments
Identifying Value	Risk Analysis
Identifying Waste	Design for Six Sigma
Value Stream Mapping	Design for x
Cycle time Analysis	Statistical Tolerancing
The Seven Wastes	Strategic Planning
5S	Porter's 5 forces
TPM	Theory of Inventive Problem Solving
Visual Management	Systematic Design
Single Piece Flow	Critical Parameter Management
Kanban	Pugh Analysis
Process Mistake Proofing - Poka Yoke	
Control Charting	
Sustaining Improvements	
Verifying Improvements	
Sharing the Knowledge Gained	

Table 3.3 outlining the typical course contents for Six Sigma Training. Adapted from *Lean-Six-Sigma-Training-Courses, n.d.)*

Master Black Belts are typically full time trainers of 'Belts', having had the most experience with Six Sigma tools and processes. (Arumugam et al., 2013; Easton & Rosenzweig, 2012; Swink & Jacobs, 2012). These Master Black Belts have received the most extensive training of any of the Belts and have proven themselves through multiple high value projects. They are normally positioned at the top of the hierarchy in a Six Sigma deployment structure as seen in Figure 3.2 (Kubiak, 2012). According to Krueger, Parast and Adams (2014) Master Black Belts have many roles including project selection, coaching Belts, training, tracking projects at three to four plants, holding Belts accountable for results and removing barriers that may limit project success.

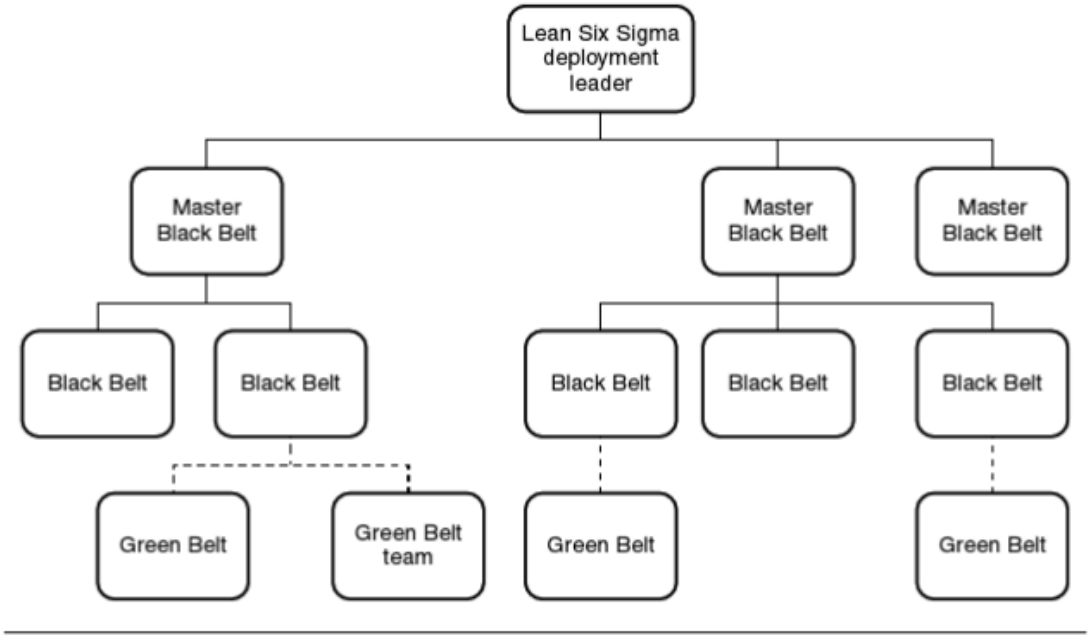


Figure 3.2: Lean Six Sigma deployment team structure.

3.2 When implemented effectively what gains does it give a business?

From the end of the 20th century organisations around the world have been placing a higher importance on Six Sigma as the benefits of savings, customer satisfaction and process improvements started to become better known (Chiarini, 2013).

The president of the Six Sigma academy, David Laux, feels that "Six Sigma can now be applied to all industries and all functions and can even be used in R&D to find innovative products" (Sony & Naik, 2012). Six Sigma has been exploited by conglomerates worldwide including, General Electric, Honeywell, Sony, and in a variety of industries including healthcare, automotive, telecommunications, electrical systems and aerospace engineering (Arumugam et al., 2013; Carvalho, Magalhaes, Varela, Sa & Goncalves, 2016; Chiarini, 2013; De Mast & Lokkerbol, 2012; Easton & Rosenzweig, 2012; Saghaei et al., 2012; Shafer & Moeller, 2012; Swink & Jacobs, 2012).

The evidence from these recent studies, in this case, the past five years, indicates that Six Sigma has a multitude of business benefits ranging from financial savings, higher level of team synergy, increased innovativeness, higher job quality and more efficient flows of communication.

One of the primary benefits of Six Sigma is financial improvement. Six Sigma is expected to achieve sizable, drastic and distinctive returns with Green Belt projects potentially saving $10,000-$50,000 per year and an average Black Belt project expecting $200,000 to $300,000 of value in an annual year (Henny, 2011; *How much can a Black Belt Save Your Company*, n.d.; *Measuring Return on Investment with Lean Six Sigma*, n.d.).

Another primary goal of Six Sigma is reducing the variability within a process or product. (Shanmugaraja et al., 2012). "As process variance is reduced that likelihood of defective parts is reduced accordingly" (Choi et al., 2012). Saghaei et al, (2012) details that research into Six Sigma throughput yields proved through real world experiment in the electronics industry. Their model of incorporating Six Sigma led to a reduction in scrap, defect levels and therefore any and all rework costs that arise in such situations.

While this particular study (Saghaei et al, 2012) took place within a manufacturing industry, Six Sigma has also been utilised in other business sectors such as the healthcare industry where the patient is effectively the product, with regards to throughput times, flow analysis and process mapping. Discussing the similarity between the two hospitals studied and known manufacturing processes it was discovered that there is a distinct similarity in characteristics. For example zero defects and risk management played a huge part in both industries, especially as the consequences for failure in the healthcare industry are literally life and death, as well as the opportunity for statistical tool applications to keep both healthcare professional and fabricators emotions out of the equation when problem solving (Chiarini, 2013). Niemeijer (as cited in De Mast & Lokkerbol, 2012) found that during a study inside a hospital's trauma nursing department, a DMAIC project substantially reduced the stay length of a patients stay.

Six Sigma can be applied as a fundamental tool in marketing, sales, distribution, HR, manufacturing and finance, all with the goal of cost reduction. The conglomerate giant 'Du Pont' reportedly achieved a cost reduction of US$1.6 billion dollars through an estimated 3,000 Six Sigma projects and training around 10,000 employees to either Master Black Belt, Black Belt or Green Belt proficiencies (Choi et al., 2012).

The metrics that Six Sigma provides allows for innovations, both within the administration of a business and in terms of technical innovation, as "innovation itself becomes a process for solving existing problems" (Sony & Naik, 2012). Using improvement specialists that have developed their skills and expertise through Six Sigma training and other various total quality management certifications have been found to positively contribute to administration and organisational

innovativeness. As an organisation reduces the variance within their processes, whether that is from process innovation, change in policy or other methods, it will give rise to a positive effect of the organisation reaching new levels of corporate competitiveness within the market (Choi et al., 2012).

Knowing that DMAIC provides a stepwise procedure that can be followed and adhered to, Six Sigma itself has also proven to foster team dynamics, flow of both information and communication and enhance knowledge creation (De Mast & Lokkerbol, 2012). The technical and social practices that surround a Six Sigma implementation have the capability to influence not only the behaviour of the individuals involved, but in the process promote knowledge creation within project teams, and in turn, enhance the performance outcomes of the assignment. Through the combination of Six Sigma and traditional Quality Management practices, an organisation using the structure that Six Sigma provides in an efficient manner will give rise to the development of a more dynamic learning environment (Arumugam et al., 2013; Swink & Jacobs, 2012).

The statistical nature of Six Sigma's focus surrounding metrics provides accurate and valid data that enhances an employee's commitment to learning, shared vision and open-mindedness (Sony & Naik, 2012). One such example can be found in Carvalho et al., (2016) during a project to foster communication and collaboration for Bosch Connect, a company within the Bosch Group. A version of Six Sigma known as Design for Six Sigma (DFSS) was used in conjunction with Define, Measure, Analyse, Design, and Verify (DMADV) methodology. DFSS is similar to DMAIC Six Sigma in that instead of focusing on improving current designs as Six Sigma would, DFSS concentrates its attention and efforts on creating new and better designs. At the culmination of the Bosch Connect project an online community forum created allowing workers at Bosch connect to share ideas and data throughout the business. The 'sign-ups' to this community were staggeringly high with 90 percent of respondents using the system, representing 71 percent of the target population

Another benefit of an organisation implementing Six Sigma that has been investigated is job quality and satisfaction; both customer and employee. We know that companies that incorporate Six Sigma into their business practices experience a financial benefit that stems from cost reductions and lower defect rates. However it has also been reported that there are additional intangible benefits that are unfortunately difficult to quantify. These benefits are customer and employee satisfaction (Choi et al., 2012). Results from a 2012 study into Six Sigma effect on corporate performance suggest that Six Sigma's greatest impact can actually be found surrounding employee productivity, rather than asset productivity. Moreover, further research uncovered that "performance advantage for Six Sigma firms on both employee productivity measures tended to be larger after adopting Six Sigma and tended to increase as additional experience was gained with Six Sigma" (Shafer & Moeller, 2012). This productivity stems from the approach towards efficient employee deployment that Six Sigma offers. This indicated that employees placed on projects that either stem from personal fondness or are run

alongside their regular duties, where they have a relatively advanced knowledge and understanding of, are run smoother and more efficient than other projects without such favourable factors (Shafer & Moeller, 2012).

3.3 What does the literature say about the likelihood of successful implementation?

The ultimate purpose of any organisation and therefore by default any project is to be successful (Burke, 2013). According to the Oxford English dictionary (2015) the definition of success is: "Noun [mass noun] 1 the accomplishment of an aim or purpose" or we can describe in further detail what project success looks like. According to Lientz (2013, p. 5) "1. A project is successful if the benefits from the changes are measured and reach or exceed those that were estimated in the project plan. 2. A project is successful if the planned benefits were achieved and are lasting or persistent".

A successful project should be one that achieves the goals/objectives that were set forth during the early stages of the project life cycle, or in the case of a Six Sigma project during the Define phase of the DMAIC methodology. But what does Six Sigma Program Success look like?

A successful Six Sigma program should be one that has been implemented with the organisation's mission and business goals in mind, with a clear objective of providing value to the organisation and developing competitive advantage (Chakravorty, 2009). Additionally, a successful Six Sigma program is one that provides a positive return on investment (ROI) for the organisation. For example once an organisation has spent considerable resources on training, and business improvement specialists, they in turn are expected to deliver value to the organisation.

From the literature sourced in this systematic literature review there is clear knowledge that many of the findings from recent papers looking at Six Sigma success can be split into two very distinct sections; findings looking at Six Sigma Project success and those findings focusing specifically on Six Sigma Program success. For this reason the literature question 'What does the literature say about the likelihood of successful implementation?' has been split into two Sections to mirror this. This is detailed below in Table. 3.4

Article	Six Sigma project Success factor						Program Success Factor	
	Critical Success Factor							
	Commitment	Leadership experience	Knowledge/Training	Measuremen	Project Structure	Resource Allocation	Commitment	Knowledge/Training
Joghee (2017)				✓				
Cox *et al.* (2016)				✓				
Carvalho, Magalhaes, Varela, Sa & Goncalves (2016)	✓						✓	
Sony & Naik (2012)	✓		✓		✓		✓	✓
De Mast & Lokkerbol (2012)					✓			
Arumugam, Antony & Kumar		✓	✓			✓		
Swink & Jacobs (2012)							✓	
Saghaei, Najafi & Noorossana				✓				
Shafer & Moeller (2012)				✓				
Easton & Rosenzweig (2012)		✓						
Choi, Kim, Leem, Lee& Hong,							✓	✓
Shanmugaraja, Nataraj & Gunasekaran (2012)								✓
Chiarini (2013)	✓				✓	✓		
Sin, Zailano, Iranmanesh & Ramayah (2015)							✓	
Zare (2013)								✓

Table 3.4: Critical Success Factors of Six Sigma projects and Programs.

"If project selection is systematically sloppy, the entire Six Sigma effort could fail" (Shanmugaraja et al., 2013). This leads us to believe that project failure leads to Six Sigma program failure, therefore the converse must be true, i.e. Project Success leads to Six Sigma program success. . Consequently the first section of this question looks at Six Sigma project success, before continuing to the final section looking at Six Sigma program success.

3.3.1 Project Success

The literature review revealed six key factors that can be attributed to the success of a Six Sigma project. A breakdown of these factors is detailed below in Figure 3.3.

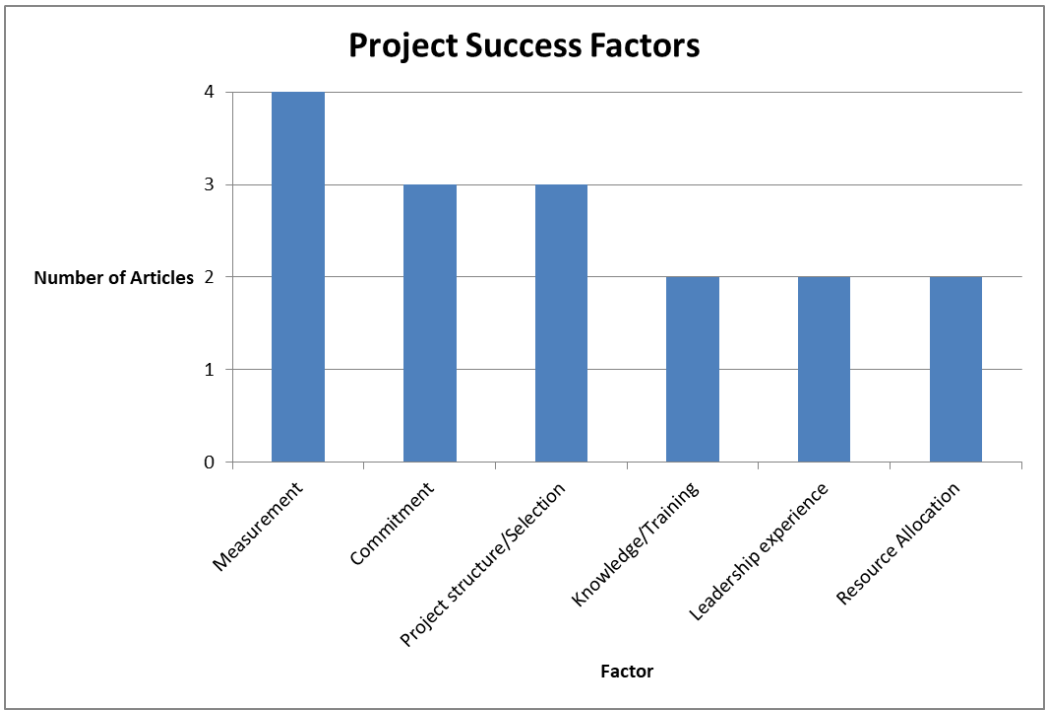


Figure 3.3: Critical Success Factors of Project Success.

Measurement

The use of correct and valid measurement systems were identified in four separate articles. Measurement refers to the accuracy and validity of data that a project must rely on. The ability of a measuring device to provide consistent measurement data is important in any system (Cox et al., 2016). The purpose of measurement data is to provide insights into the problem that the team was created to solve. One such example of a measurement tool within Six Sigma is the quality control tools (SPC) which track a process and notify the user when the system has fallen out of specifications, and also rolled throughput yields which are a method of calculating performance based on the process, efficiency and effectiveness (Joghee, 2017; Saghaei et al., 2012). Firms that react quicker to the first signs of a deteriorating performance have been shown to be operating at a higher rate of competitiveness. This is due to their ability to detect issues more readily (Shafer & Moeller, 2012).

Without accurate measurement there is every opportunity that what was once conceived a problem might not be as serious as first suspected or even non-existent.

Commitment

In total there were three articles that determined that manager and senior level employee's commitment were related to the success of a Six Sigma project. An essential factor for the success of a Six Sigma project is the involvement of senior leaders within the organisation (Carvalho et al., 2016). Managers within an organisation have the responsibility to ensure the working conditions facilitate and allow for the development of strategic factors in order to improve innovation (Sony & Naik, 2012). It is imperative that associates and managers lead by example and are committed with regards to working on a project. Their responsibility is to foster an environment where they can provide whatever support is required to assist and keep the project moving in the right direction. But they also allow the team leader freedom throughout the duration of the project. If the climate that the organisation works under created rules that are deemed too strict this can also lead to the failure of a Six Sigma project (Chiarini, 2013).

Project Structure

Project structure begins to play a role in the likelihood of a project succeeding when the project is titled either well- or ill-structured. There is no common definition of what a 'well- structured' project is, however, reports label it as "a well-structured problem is generally described as one for which the problem solver, although he or she does not know the solution, at least knows how to approach it"…and an ill- structured project tends to be when "a scheme attempting to find a solution is not available or the problem solver does not recognize it, and there is lack of clarity about how the problem should be approached" (De Mast & Lokkerbol, 2012).

Six Sigma's focus on role structure and metrics provide positive impacts on innovativeness within a project and also to the organisation in general (Sony & Naik, 2012). The DMAIC methodology is one example of problem solving method that provides structure towards a project. For complex projects DMAIC can provide the structure and a precise roadmap that can be followed to navigate a team through unforeseen issues that may arise. However, as previously stated, one alternate view is that the while DMAIC is applicable to a wide range of projects, it is more effective in routine, 'generic' projects. It is not however suitable to ill- structured projects that deal heavily in and place great value on individuals' beliefs and subjective perceptions about the issue at hand (De Mast & Lokkerbol, 2012). This is possibly due to the logical and statistical nature of Six Sigma and other soft skills might be required such as leading employees that may not have be as comfortable as using advanced statistical techniques that are at times required in a Six Sigma project. It is times like this that teachings on training and leadership skills become invaluable (Chiarini, 2013).

Knowledge/Training

The fourth factor that can have an effect upon a Six Sigma project success is the level of knowledge or training that is available. The theory that levels of knowledge and training were related to the success of a Six Sigma project were found in only two articles within this systematic literature search. However, as both articles were based on empirical investigations the researcher felt that due to the nature of the investigation which was based on observable effects it was included within the findings. Both knowledge transfer and knowledge creation within process improvement projects will enhance performance of members within that project. The project team will convert individual knowledge into collective team knowledge that can be utilised (Arumugam et al., 2013).

The collective knowledge that comes with members grouping together and sharing ideas, questioning one another and brainstorming will have a positive effect on the outcome of the solution. There is the potential for a higher quality solution due to everyone's involvement. Also utilising improvement specialists, for example Black Belts developed through Six Sigma training and various certification programs, will positively contribute to organisational innovativeness (Sony & Naik, 2012). Investing effort and resources into an organisations employees will have a positive effect as they will understand the tools and structure the Six Sigma and DMAIC provide and hence will be able to use these effectively within the project to ensure a successful outcome.

Leadership Experience

Once again literature looks towards the leaders and Managers in having a direct relationship with Six Sigma project success. Four types of experience were investigated; individual experience, organisational experience, team leader experience and team familiarity. All four were statistically investigated with only team leader experience being found statistically significant. Stating that ' Clearly, the experience that a team leader has leading projects goes a long way in improving the odds of Six Sigma projects' success and 'the team leader is probably the most important facilitator in terms of driving problem-solving process like DMAIC and the effective use of no statistical and statistical tools' (Easton & Rosenzweig, 2012). The implication is that that everyone begins at the point of either none or little experience. During that time it is imperative that the organisation provides support where necessary. Leader experience was found to influence 'knowing how' which can be defined as having a "broader set of knowledge that a Six Sigma team acquires during the Analyse, Improve and Control phases of DMAIC," (Arumugam et al., 2013). This relates back to the findings regarding the collective group knowledge and shows that leadership experience plays a role in facilitating this.

Resource Allocation

The efficiency in how resources are allocated and also to whom they are allocated to plays a role to the success rates of a Six Sigma project. Arumugam (2013) found through empirical analysis that resource allocation methods were related to project success. A regression analysis of data collected through surveys of 52 projects resources were positively associated with project success, stating that "Managers, therefore need to ensure better team climate in addition to project resources to project teams that help knowledge creation". Chiarini (2013) supports this claim with evidence of its own, taken from within the healthcare sector. Often there is a critical balancing act between economic resources available, and in this case, projects to increase patient satisfaction. It is not uncommon to find reports of European hospitals that patient satisfaction increases as the budget rises also. This is presumably due to the financial cash flow available for training and extra assets. However resources don't necessarily need to be financial. As previously discussed the level of training and knowledge comes into play when conducting as a Six Sigma project. An organisation should not be hesitant in bringing in specialists with relevant qualifications provided that at the conclusion of the project it has provided a positive benefit for the organisation.

3.3.2 Program Success

The second half of this literature review looks at the reports of factors that are related to the successful implementation of a Six Sigma program within an organisation. From the articles that were included in the study the researcher found a total of two factors (Commitment and Knowledge) that related specifically towards a successful implementation of a Six Sigma Program. While other factors of project success overlap into program success, these two they have been included due to the additional information collated that did not apply directly towards project success. A breakdown is shown in Figure 3.4.

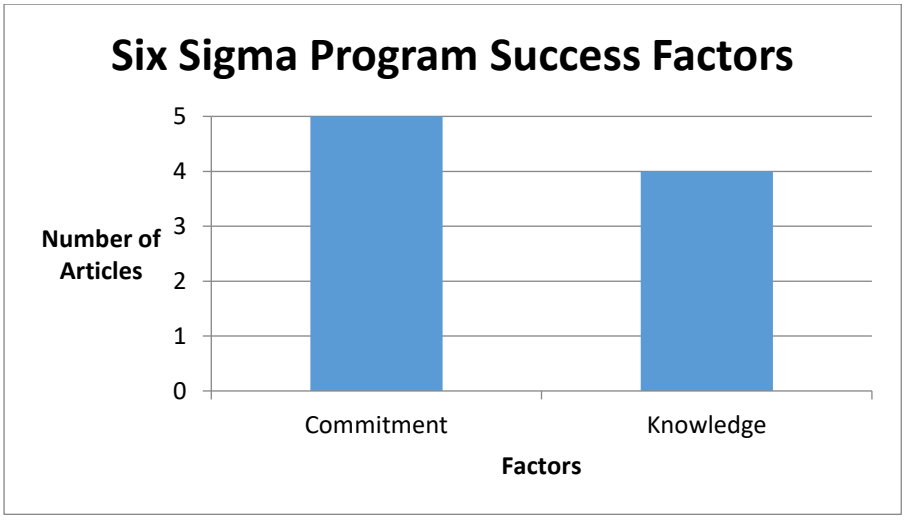


Figure. 3.4: Six Sigma Program Success Factors.

Commitment

Any new business goal or strategy is normally a top down decision made by the senior level management. For this reason 'commitment' is high on the list of factors and the reason it has been mentioned so frequently in this literature review. Six Sigma must be linked with business strategy, relate to the organisations core processes and at its ultimate provide value to the organisation (Sin, Zailano, Iranmanesh & Ramayah, 2015). 'The CEO's will' has been used to describe the level of assurance and guarantee when looking at the activities that are substantial for Six Sigma management activities. Managers/associates have an important role to play as they create the condition best suited for the project; conditions that provide the opportunity to allow strategic discussion, all of this is fundamental to the success of a Six Sigma program (Carvalho et al., 2016; Choi et al., 2012; Sony & Naik, 2012).

Managers that choose to adopt Six Sigma into their organisation should be wary about how long tangible benefits might take to become apparent. Managers should be willing to wait upwards of two to three years before the effects of a Six Sigma project start to become obvious (Swink & Jacobs, 2012). Managers should keep this in mind and ask themselves 'can the business and more importantly can I stay committed to Six Sigma development for that period of time?' However, logically to the researcher, the success of a project should become apparent within a smaller period of time. This should be upon verification that the 'Control' phase of a project has been successfully implemented.

Knowledge/Training

The purpose of upskilling employees to the various levels of Six Sigma (Green/Black Belt) is an investment into the future of an organisation as the lack of quality learning has the potential to cause improper implementation of quality methods such as Six Sigma. Quality learning (training) is essential for facilitating a change within the business environment (Sony & Naik, 2012). The success of Six Sigma projects lead to competitiveness for an organisation (Choi et al., 2012). However, these projects cannot be completed without the trained specialist Green and Black Belts that understand the tools. Similarly implementing a successful business wide Six Sigma program would require an experienced Master Black Belt. It is from this training that employees gain the skills necessary to run Six Sigma projects across the organisation and importantly to select the projects that provide the most value to the organisation. These skills include, project management, statistical tools, leadership techniques, and project selection (Sin et al., 2015; Shanmugaraja et al., 2013).

3.4 What evidence is there that Six Sigma has been implemented in New Zealand?

Unfortunately research relating to Six Sigma usage in New Zealand is limited. The initial systematic literature review did not provide any results. For this reason a second search was undertaken using the same data base. However, this search cleared the constraints and searched for the terms 'Six

Sigma' and 'New Zealand'. Only three articles containing studies that focused on New Zealand businesses were found. The most useful of these was a thesis that surveyed 33 manufacturing firms from around New Zealand, while seeking to find a positive relationship between Lean Six Sigma and organisational performance outcomes (Ngo, 2010). Of the remaining two articles reviewed, only one named the business case; Inland Revenue Department (Elias, 2016) and the other was simply referred to as 'Company F' (Corbett, 2011). From this information we can conclude that at least 34 businesses in New Zealand have implemented Six Sigma as we do not know if the unnamed business was a source of data for the other papers as well.

However, this is not only literature evidence that Six Sigma is being implemented within New Zealand. Job listings on job seeking sites such as 'seek.co.nz', 'trademejob.co.nz' at times require job applicants to be versed in Six Sigma methodology. Additionally, there are organisations that specialise in the training of Six Sigma belts such as the 'Thornley Group' who state on their website that they are "Specialising in Lean Six Sigma training, our services range from hands-on consultancy to on-site delivery of training programmes" and can provide "Certified Six-Sigma Black Belt, Green Belt and Yellow Belt training to National Standards" [*Why Pursue Business Excellence?]. (n.d)* Although the list of literature is small the fact that there are job listings searching for "You will be a degree qualified chemical engineer, Six Sigma Certified and have a minimum of three years' experience in the development and implementation of Six Sigma frameworks within manufacturing environments" (*Job advertisement-engineer, n.d.*) and "Knowledge and ability to apply Lean Six Sigma principles is preferred" (*Job advertisement-Manufacturing, n.d.***)** clearly shows evidence that Six Sigma is being implemented within New Zealand Businesses and there is a demand for those with knowhow and have experience working with such systems.

3.5 What is the level of reported successful implementation in New Zealand?

Once again similar to the previous research question there is little to no research that has specifically looked at Six Sigma implementation in New Zealand. Thus, there appears to be a major gap in the literature. By endeavouring to identify new information or data to fill this gap there is the opportunity to reinforce current literature theories or even reveal new theories.

Currently from literature Question Four it is known that at least 34 businesses have implemented some form of Six Sigma methodologies into their business processes. Statistics indicate that New Zealand had 595,124 registered companies as at 31 October 2017 (New Zealand Companies Office, 2017). Hence, to have only 34 businesses that have implemented Six Sigma in New Zealand is a very small proportion compared to the total number of businesses in New Zealand. However, without evidence there is not a great deal of valid information we can gather as to how successful implementation may have been. However, as there are numerous organisations in New Zealand that

have the capability to provide training for Six Sigma certifications, (www.yellowhouse.net, www.thornleygroup.co.nz, www.lean6sigma.co.nz, www.auldhouse.co.nz). These organisations will be offering these Six Sigma training courses to fulfil the business demand for Six Sigma certified employees. Therefore, we know that there are definitely Six Sigma certified workers in New Zealand. Hence, it would be reasonable to assume there are successful and strong Six Sigma programs functioning nationwide. However, these are merely assumptions and currently cannot be held to a degree of academic certainty. This demonstrates an opportunity for future research.

3.6 Chapter Summary

The focus of this chapter was to explore current trends in literature. This was achieved through a systematic literature review using the PRISMA method. During the review five literature questions were answered.

Question One was simply 'What is Six Sigma?' This question looked at the origins of Six Sigma, some of the tools and components incorporated within the Six Sigma boundaries, and also looked at how and why the DMAIC method is used so frequently.

Question Two, titled 'When implemented effectively what gains does Six Sigma give to a business?' investigated the benefits that Six Sigma can produce. These benefits include financial savings, higher team synergy, increased innovativeness and creativity, increased job quality for employees and increased flows of communication within an organisation.

Question Three is where the research commences to look towards the data that would relate to the research question proposed at the beginning of the thesis; 'What does the literature say about the likelihood of successful implementation?' The findings from this pathway of questioning produced two areas of findings; 'Project Success' and 'Program Success'.

Success factors for Six Sigma 'project success' include commitment from project members, knowledge and training levels, leadership experience, measurement accuracy, project structuring/selection and resource allocation.

Six Sigma 'program success' shows evidence of very similar attributes for success, with two extra factors not found in project success. These factors are commitment from senior management and knowledge/ training of those choosing and facilitating the implementation of a Six Sigma program.

Question Four from this literature review took the form of 'What evidence is there that Six Sigma has been implemented in New Zealand?' Findings from the literature indicate that there has been very limited evidence of Six Sigma implementation in New Zealand. From the few studies found the data indicates that there are at least 34 organisations within New Zealand that are currently utilising Six Sigma to some degree within their business practices. These findings were discovered through three articles and job listings.

Question Five looks that evidence of successful Six Sigma implementation. Utilising the knowledge gained from Question Four there is evidence that Six Sigma is currently in use, combined with the assumptions taken from the fact that there are numerous organisations that offer Six Sigma training, that there must be strong and successful Six Sigma programs are in place throughout New Zealand.

Following is Chapter Four which is a synopsis of the projects that were the focal point of the interviews, as well as summary of the interview participants involved, their interviews and coded transcriptions.

4. Case Study description and data collection

4.1 Introduction

This chapter investigates in detail the data collected from the semi-structured interviews that took place on site at the case study organisation.

The chapter includes an introduction and summary of the case study organisation.

Covered within this chapter are the reasons for inclusion of the research, size of the case study organisation and to the degree Six Sigma is utilised on site. Details on the projects studied are listed, including project drivers, Belt colour of project lead, degree of success and other significant notes that were deemed relatable to the research. Additional details obtained during the interview participants are also listed. Notable factors include Belt colour on team members, simplified job description, training received and length of time working with Six Sigma techniques. The interviews themselves have been transcribed, dissected and documented by listing categories once sorted and coded. Conclusions are presented as well as informative sections/quotes that relate directly to the research question.

4.2 Case Study Organisation

In order to gain the data required to complete this research it was decided to incorporate a medium to large sized organisation. The rationale for this was being a large sized organisation the case study would be able to accommodate the needs of data collection as well as being large enough to provide a wide range of interview participants.

The Case Study Organisation that was chosen as the focus of this research was a large manufacturing company with export sale revenue of approximately NZ$1billon per financial year employing approximately 800 full time employees and contractors on site. The Case Study Organisation contributes 10.5% of the regions GDP. In 2016 the employed 39 Green Belts, 18 Black Belts and one Master Black Belt. As of 2017 these numbers have risen, due to planned training courses.

The organisation consists of a flat four-tier managerial structure comprising of General Manager/CEO with five reporting department managers, of which three are operational departments and two are departments providing support services. At lower levels to department managers are team leaders, then team members.

The business improvement team is located within an operational department and comprises a Master Black Belt, who reports to the department manager, and four Black Belts. The Black Belts work solely on complex site business improvements and provide guidance to Green Belts.

Within the five departments there are numerous trained Green Belts in various roles, who do improvement projects within their own departments as part of their work role. The researcher

identified that once Black Belts have completed their training, been certified and spent approximately two years Black Belt project work, they return to operational roles.

The business improvement team organise the annual business planning process and the annual 'deep dive'. This 'deep dive' is performed over a one week period mid-year and is an essential part of the business planning and improvement process. All ideas for improvements for the Case Study Organisation for the coming year are proposed, evaluated and ranked according to the benefit-effort matrix. The projects which are accepted to go forward for the next 12 months are placed in the site 'project hopper'. Participants in the annual planning and deep dive are most leaders from the operations departments and some support staff (usually technical specialists) invited from the departments when it is deemed that they will provide additional value to the deep dive.

In addition to the projects being progressed from the site hopper, at any one time there are at least five business improvement projects being undertaken by the Black Belts in the business improvement team. These are known as the five 'Critical Few' and are selected as being critical to achieve the businesses performance goals, either in the short term or over the business year. Other projects are assigned in addition to the 'Critical Few' depending on business needs, for example, if a production process is 'out of control' and site resources need to be assigned to bring the production process back into control as quickly as possible. These may be influenced by an unexpected change, for example, raw materials affecting the manufacturing process or a change in regulatory requirements requiring significant resources to achieve compliance within a short time period.

Green Belts within their department complete projects as part of their work role. Ordinarily Green Belts would have a minimum of two projects allocated to them in a given year. However, high performing Green Belts are expected to complete four projects per year. These projects may come from a site hopper or otherwise are assigned by the department manager who would be the project sponsor.

The Master Black Belt is accountable for delivering annual training of new Green Belts and to further the training of existing Green Belts and Black Belts. In addition to their training responsibilities they are also expected to maintain a thorough understanding of all business improvement projects that are undertaken onsite.

This specific organisation was chosen due to the previous experience and connections with the business. The researcher has a personal connection with the organisation, having worked there himself for two university summer vacations, additionally having family connections in various departments totalling up to 22 years work service.

Importantly, it should be noted that all participants interviewed had no prior connection with the researcher. The advantage of having previous experience and knowledge of the Case Study

Organisation meant that the researcher knew the business and its practices. There was no need to ask questions regarding the departments' purpose, what tools/machines did what, or the meaning of site specific acronyms. However, the strongest reason this organisation was chosen is the fact that Six Sigma has been a part of the organisations' daily business practices for over 15 years. It is so prevalently used that even during the researcher's time of working during two summer university vacations he had experienced various Six Sigma tools and practices first hand.

Knowing that there was such a strong Six Sigma program that had been successfully implemented played a huge role in the selection criteria for the case study organisation

4.3 Project Breakdown

This research concentrated on 11 projects that took place at the case study organisation. As the research question for this thesis focused on success factors, all of the projects studied had been concluded and signed off as being complete, or at the very least in the final "control' stage. These projects chosen for the study originated from the five departments in order to gain a range of project types. This was accomplished by assembling a list of projects and employees that would bring a range of knowledge and depth of experience over a wide array of job responsibilities.

As with the range of departments the projects also had a range of driving factors. These factors include:

- Financial
    - Produce a financial benefit for the organisation. Either by reducing costs or creating additional value.
- Health and safety
    - Improve current health and safety protocols on site to improve the safety of the organisations workers.
- Process efficiency
    - Increase the efficiency of procedures on site.
- Quality improvement
    - Increase the quality of goods being produced.
- Process improvement
    - Improve the processes on site. This might be achieved through new technology or upgrades to existing assets.

While this was not necessarily focused upon during the planning stages, it was a welcome secondary attribute that provided evidence showing that the projects were not identical and provided the opportunity to gather a wider range of data. Table 4.1 shows the breakdown of each project and the corresponding driving factors

Project Number	Driving Factor				
	Financial	Health and Safety	Process Efficiency	Quality	Process Improvement
1	X				
2	X				
3		X	X		
4	X				X
5	X	X			
6		X			
7			X		
8	X		X		
9	X		X		
10					X
11				X	X

Table 4.1 Breakdown of projects by driving factors.

As previously stated this research focus is on successful projects. But what constitutes success? There are differing definitions of 'success', especially when looked at from a business perspective than a sporting or literal dictionary definition.

As previously stated the ultimate purpose of any organisation and therefore by default any project is to be successful (Burke, 2013). The Case Study Organisation however had developed a personal definition of success which ultimately stemmed from a business and manufacturing perspective. Success to them is measured by:

- Value added product revenue ($),
    - Total dollar amount of value attributed to products sold.
- Production tonnes (t),
    - Total weight of product produced in tonnes.
- Production cost ($/t),
    - Cost of production per tonne.
- Asset integrity (% complete),
    - Level to which an asset is able to perform its duties effectively and efficiently.
- Business improvement value ($),
    - Total financial value of business improvements provided to the business on an annual basis.
- Engagement (% change),
    - Measured as part of a biennial employee work satisfaction survey.
- Critical Risk Management (% complete)

- Progress towards completion of the elimination of fatality risks at the Case Study Organisation.

A more detailed breakdown of success factors can be found below in Figure 4.1

Figure 4.1 Case Study Organisation Success Quadrant. Provided by the Case Study Organisation.

In conclusion all projects were chosen specifically to provide a range of data that revealed data and information from the departments throughout the case study organisation. This combined differing driving factors providing the researcher with a great deal of information regarding project specifics that were taken into account when paired with the interviews during the analysis phase.

4.4 Interview Participants

The interviews were split into two separate groups; project leaders and senior management. However, there was one crossover where one member of senior management was also project leader. Of these interviewees eight were Green Belt certified, six were Black Belt certified and one was a Master Black Belt.

The interview questions that were asked are below. Further details regarding the interview questions can be found in Appendix 1.

Senior Management:

1. For my study I looked at projects that specifically use Six Sigma methodology. Can you please outline your Six Sigma program? For example the implementation process and the projects that have utilised Six Sigma methodologies?
2. I am interested in understanding the factors that contribute to the success of a project. Can you please explain what makes a project successful and why?
3. What aspects of problem solving and using DMAIC was challenging for teams?
4. Can you comment on the team leadership, functioning and the support that you provide?

Project Leaders and Team Members.

1. Can you please give me a brief background on the project?
2. To what extent was the project a success? Why?
3. What went well with the project? What else would have helped to further improve the working of the team and achieving the project objectives?
4. Have you used DMAIC methodology? If so, what steps of did you find challenging? What were the positives regarding DMAIC? How did they contribute to the outcome of the project?

From the sample of 11 projects, nine of the projects were classed as a success as they met/surpassed the objectives/goals set during the define phase of the project.

The remaining two projects did not continue and were stopped prior to the end of DMAIC. One project was cut short due to a business decision that project success was not feasible under the guise of Green Belt training and due to the complexity of the project required additional leadership experience to be successful. The remaining project was terminated during the 'measure' phase once it was discovered that the measurement system being utilised was inaccurate.

While these two projects may not have been successful in name as they were ultimately stopped and therefore did not reach the objectives stated in the initial project documentation 'Project A3s' , they were arguably successful in nature. Both projects laid the foundation for future Six Sigma projects. The project that discovered inaccuracies within the businesses measurement practices provided undeniable benefit with regards to future measurement. As a result of these new findings being out of the project scope, a separate project was completed to design a more modern, custom system that had significant acceptance from the users. Output from this project still remains in use to this day.

In total 11 employees were formally interviewed during the course of data collection. The project leaders selected for this research were not chosen for any particular reason. They simply happened to be leader of the projects. The researcher did not know the identities of the interviewees until after the project list had been finalised. The senior managers in contrast were approached due to their involvement in either the business improvement experience, departmental knowledge or their all-round insight into the projects being undertaken at the case study organisation and their ability to see the larger picture. All senior managers had achieved qualifications of Black Belt or higher.

4.5 Coded Interviews

A detailed breakdown of the coded interviews is located in Appendix 2.

These coded interviews contain excerpts from the interview, researcher's thoughts/coding and finally the group/category that the quote/data was sorted into.

For confidentiality reason these interviews have been redacted. Employee names, product details, organisation name, department name and project names simply read EMPLOYEE, PRODUCT PROJECT, DEPARMENT, ORGANISATION, or TEAM.

4.6 Summary

This chapter investigates in detail the data collected from the semi-structured interviews that took place on site at the case study organisation. The chapter begins by presenting information regarding the Case Study Organisation. Outlined here is information regarding the organisations structural hierarchy, strategic decision making process, project selection method and the roles of the Master Black, Black and Green belts on site.

This chapter then moves to providing a breakdown of the projects studied, including the number included in the studied and driving factors of each project.

The chapter then proceeds to look at how the organisation defines success, providing criteria and additional information retrieved from the Case Study Organisation to provide evidence.

Furthermore this chapter provides details regarding the semi structured interview. Information provided includes details on the interview participants, interview questions, which projects were successful/unsuccessful.

Finally, this chapter provides information on the coded data tables that are located in Appendix 2. These tables have been redacted and reasoning and methods for this were explained.

Chapter Five contains the results from the interviews at the Case Study Organisation.

5. Results

5.1 Introduction

Findings from the analysis are consistent with and support the theories put forward in current academic research.

These academic findings from the interviews at the Case Study Organisation are similar to the Critical Success Factors identified in the systematic literature review. However some are more important than others. The list below provides these Critical Success Factors ranked in accordance to the researchers' understanding of importance:

- Employee Acceptance,
- Project Structure,
- Commitment,
- Measurement Accuracy
- Resource Allocation,
- Knowledge and training, and
- Experience.

However, there is a notable exception which has become clearly evident from the analysis of the interviews at the Case Study Organisation. **This new finding is how important the concept of 'acceptance' is to the success of a project.**

The literature review on the implementation and success of Six Sigma worldwide and within New Zealand has not identified or documented this finding of 'acceptance' in a business case scenario.

'Acceptance' is defined in this context as meaning that once a Six Sigma project has been undertaken, improvement ideas identified, evaluated, tested and implemented in the 'Control' phase, it is the 'acceptance' or willingness of any new a method/use of different procedures/implementation of new technology by the end user (i.e. the person/team in the workplace) that contributes significantly to the long term successful embedding of any associated change. However in order to reach the appropriate employee acceptance levels during the control phase, information obtained from the Interviews indicates that the project goal of ensuring 'employee acceptance' must be introduced from the very beginning of the project during the Define stage, and then nurtured by the Project Sponsor and Project Leader throughout the entire DMAIC methodology and project lifecycle.

Also identified in the interviews was the importance of "Commitment' to success of Six Sigma Projects, specifically senior management commitment. This is observed at three different stages of a project.

1. Stage 1: the calculation of a 'Commitment rating' at the define stage of the Project A3 which will define the level of support required for project success. Table 5.1 obtained from the Case Study Organisation outlines the commitment ratings and various levels of support required to ensure project success. The complete Commitment Rating template is attached to this research as Appendix 5

Score	Action Required
90- 100	Highly Confident to Proceed
80 – 89	Confident to Proceed
70-79	Will need to be monitored closely & will need active sponsor support/involvement
60 – 69	Concern! Will need active coaching support from MBB/Manager BI
50 – 59	Danger! Needs further discussion before launching
Less than 50	Stop! Do not start as defined

Table 5.1 Commitment Rating Guidelines. Obtained from the Case Study Organisation

2. The Commitment of General Manager and Department Managers in routinely attending Six Sigma Gate reviews, even when projects being presented are not associated with their Department.
3. The enduring commitment to providing resources (Financial, Assets, Time and People) was identified as being required for Six Sigma project success. This enduring commitment must be present throughout all stages of the project's life cycle, and importantly once the project has passed the Control phase to enable successful long term embedding of the value gained to the organisation.

5.2 Case study Organisation Value

Information obtained at the interviews strongly indicates that an integral part of the fundamental work of the Six Sigma Project Sponsor and the Project Leader is to manage implementation to ensure 'acceptance' by integrated change management in the workplace. For example this could take the form of locking the project approval and start dates in the Project A3, ensuring that any attempt to revert or make changes to the Six Sigma project results require appropriate analysis and approvals.

Additionally, with the Case Study Organisation a fundamental success factor of Six Sigma, is not only within project work, but with the integration of Six Sigma methodologies into the business operating model. At the Case Study Organisation, the DMAIC process for improvement work has become embedded across the site within all teams and departments. Furthermore, this integration of Six

Sigma methodology within the Case Study Organisation has led to the annual business planning process to achieve spectacular results over the longer term. This is demonstrated by annual financial cost savings of approximately NZ$30million per year over a fifteen year period being achieved by ensuring high value improvement projects are identified and executed with appropriate commitment.

Accelerated value delivery in 2010/2011 was gained from key improvements of combining Lean and Six Sigma and additional Belt resources from completion of formal training programmes. Figure 5.1 clearly shows the accelerated value delivery once additional Six Sigma resources were introduced to the Case Study Organisation in 2011.

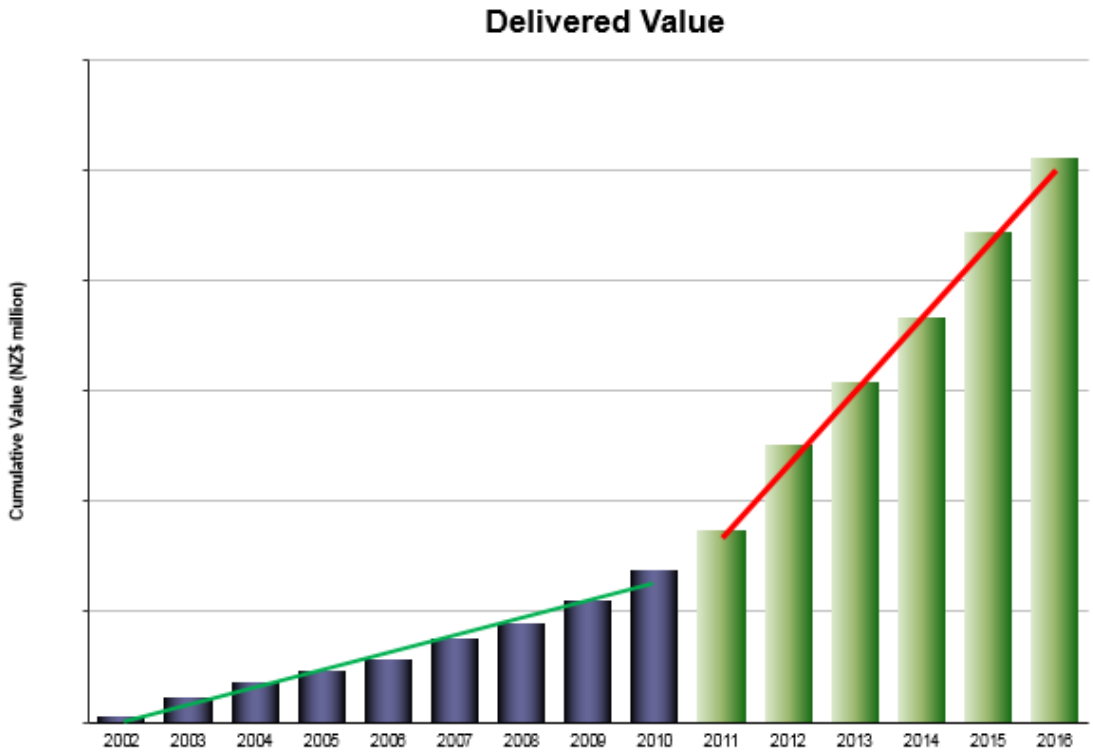


Figure 5.1: Cumulative Annual Value from Six Sigma driven Improvements. Obtained from the Case Study Organisation.

These increased values were created through a series of key improvements. These key Improvements were gained from:

- Formalised gate reviews for all Projects,
- Speed of projects and not letting them fail by ensuring resource allocation was appropriate,
- A formal Project Team launch to gain acceptance, and
- Commitment of Sponsors, Owners & Facilitators to ensure success.

Not all DMAIC projects necessarily have a time schedule of many weeks. Success from Six Sigma projects has driven the use of Six Sigma fundamentals across the whole business model, for example the use of 'DMAIC Everyday' for routine improvement.

The Case Study Organisation has defined 'DMAIC Everyday' as utilising Six Sigma tools for problem solving during the routine daily work of individuals. For tasks or projects that are too small to undertake as a Green/Black Belt project due to their limited duration (several hours up to three days), 'DMAIC Everyday' is used to provide a structure and rigor to the task and to use the steps and tools of DMAIC, just on a smaller time frame. It is the Case Study Organisation's belief that:

> *"Without following the DMAIC steps we tend to fall into a Measure, Analyse, and Improve approach. This means we don't really understand the problem as it is not clearly defined. Then we analyse, improve, analyse and improve on what we thing the problem might be, then we move on to the next problem without locking in the gains from this one."* (Case Study Organisation, Business Improvement Manager, personal communication, 23 June 2017)

Essentially a 'Project A3' is used to outline the problem, context and to ensure the appropriate measurement system, analysis and improvements are applied to ensure a successful outcome. These A3's contain all relevant information required during the define phase of the DMAIC methodology. This relevant information includes

- Project title, coach and sponsor,
- Context and problem/opportunity statement,
- Business impact/gains to the organisation,
- Key metrics (primary and secondary),
- Scope of the project. (SIPOC used to determine this),
- Project team members, individual time commitment (%) and resources required,
- Project commitment rating,
- Approvals established and project start date,
- Risk assessment,
- Initial stakeholder review, and
- Project planning dates for each DMAIC phase.

The time scale of a DMAIC everyday project is typically one to seven days from initiation to conclusion. (Case Study Organisation, General Manager, personal communication, 21 June 2017)

Successful project execution does not require the use all the Six Sigma tools, only the tools which are appropriate to the project. This is where the experience and knowledge of a Black Belt and / or the Project Leader comes into fruition.

The Case Study Organisation has not only successfully implemented Sig Sigma for improvements to its business planning systems and manufacturing processes, but has extended this success into health and safety improvements, plant and product design. As witnessed through the diverse driving factors of the projects studied (Financial, Health and Safety, Process efficiency, Quality, & Process Improvement).

Importantly, the Business Improvement team works with the entire site to move the culture to one where improvement just happens through partnership and coaching and to ensure the best projects are being worked on through transformation and critical few.

At the Case study Organisation, site wide projects are developed from the annual week long 'deep dive' business planning process (attended by the researcher), or in response to a change in business circumstance, are placed in a 'hopper' and ranked according to a benefit effort matrix. Those projects that are high benefit low effort are 'just do's.' Those projects that are low value and high effort are not proceeded with in that planning year. The remaining projects are ranked by quantifiable business value. Of those projects in the project hopper only four to five are undertaken at any one time, each with their own assigned Black Belt as project leader. Once a project is completed, the next ranked project in the project hopper will take its place.

All projects in the project hopper had well developed Project A3's, enabling projects of high value to be identified and the benefits understood and total value to the organisation ranked. As depicted in Figure 5.2 Benefit/Effort matrix 'just do's' will be situated in the green and blue sectors, projects not included within the project hopper are in the red sector and all other projects i.e. the critical few, are will come from the orange sector.

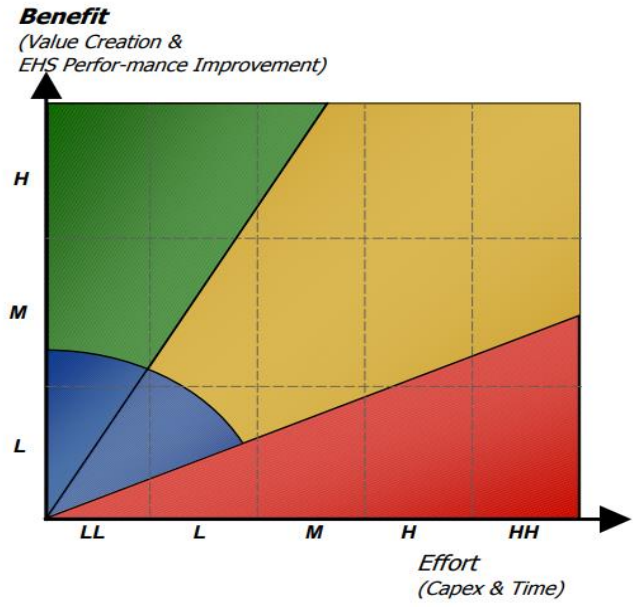


Figure 5.2 Benefit Effort Matrix. Obtained from the Case Study Organisation

The reason the Case Study Organisation undertakes a maximum of five critical projects at any one time is that it can focus resources and effort to complete projects quickly and thus deliver business value promptly. This prevents a multitude of projects being undertaken at any one time, stretching resources, and not delivering value. The focus on ensuring the critical few are completed successfully is a major factor in ensuring Six Sigma processes continue to be developed and used business wide. Progress of each critical few project is tracked weekly with critical review by the General Manager and senior management team. The researcher was fortunate enough to attend several of these meetings and witnessed first-hand successful Six Sigma in action.

5.3 Project Structure- Two critical phases: Define & Control

The structure that a project requires is provided through the DMAIC methodology. Broken into the five stages of Define, Measure, Analyse, Improve and Control, each step must be completed before moving onto the next. The monitoring of project progress at each stage and to ensure each stage is completed to an acceptable standard, all Six Sigma projects must go through a 'gate review' with the Project Sponsor. The Project Leader presents the results to date and the tools used. Some gate reviews are attended by other Six Sigma Belts who will critically review the stage and offer alternative perspective outside the immediate project team or knowledge group. It is the Project Sponsor who will either 'accept' the project work to date at that stage or otherwise require additional work.

> *"It's called DMAIC for a reason and every phase is absolutely essential to have confidence to go on to the next phase without having a whole lot of rework…So I guess the key success criteria I think is systematically going through the DMAIC process and having gate reviews were everyone is lined up and go through what's been achieved throughout that phase.* (Interview 6)

Analysis from the interviews showed that in six separate Interviews 'Project Structure' was attributed as a major factor that contributes towards Six Sigma Success.

From all the interviews the 'Define' stage of DMAIC was mentioned most frequently as playing an important role in project success

> *"Define is very important, so defining what is the issue, we are really trying to understand it and then you get into your Measurement and my personal experience is that's an area where a lot of times that step is missed……. So DMAIC that defining and setting the boundaries is really critical so you know where the scope is and don't creep and grow the project, Measure is critical, absolutely important... is critical you don't scope a large project….. if you define the project well and you really do need to spend the time up front defining it well and understanding what the success factors would be then um, that sets you up for the best chance of success." (*Interview 2)

> *"I think the key thing to get done right is the project Charter. …and I've probably noticed that with when you're looking at scope of work right, what's in scope is if you've got SIPOC right…. identifying everything you want in it." (*Interview 3)

SIPOC is defined as "a high level process that includes reference to Suppliers, Inputs, Process, Outputs, and Customers" "SIPOC is a very effective communications tool. It ensures all team members are all viewing the process in the same way" and "It also informs leadership of exactly what the team is working on**"** (Rath & Strong, n.d.)

> *"With the goals being narrowed, taking the Scope from that was very helpful. But a lot of the Six Sigma tools, like the process map, what does the process look like, what does the measurement look like, what would the secondary metric be."* (Interview 5)

> *"I guess the other success criteria is that process enables people to come up with solutions that they may not have come up with before. So effectively its taking away some constraints to the whole construct behind DMAIC, is you diverge and come up with some quite divergent thinking..."* (Interview 8)

> *"There is a tendency here to 'boil the ocean' or 'eat the elephant' we scope a project as fix world hunger, so a project that's way too big*." (Interview 9)

> *"That's always important because if you don't have the Scope right, then you might be working on a problem that the site doesn't want solved. You have to define the problem you want to solve and get everyone's agreement. Just have a conversation, saying this is what I want you to do. If you don't come back with a Define stage you could actually be misunderstanding it*." (Interview 10)

From these excerpts of the interviews we can understand how important the Define stage of DMAIC is in the beginning stages of a Six Sigma project. It allows the Project Leader to understand what is in and out of Scope (Interviews 2 & 3), investigates and concludes what the primary and secondary metrics are to allow the measurement and Control stage to function efficiently, and ensures that the project is not trying to 'boil the ocean or 'eat the elephant' (Interview 9). Simply making sure the project is not overreaching or extending itself too far, possibly the project needs to be broken down into a series of smaller projects or the overall objective is too large, either way the Define stage keeps the project grounded. Finally the Define stage also sets the scope for the project to ensure that everyone involved understands the objective of the project and the problem at hand. (Interview 10).

However the Define phase is not the only important phase of DMAIC that was identified. The Control phase was also identified as playing an exceptionally important role.

"We've put in the Improve phase and then two years, three years later, we are right back to the same problem because we haven't locked in the Control side of it…….But if we put all the controls in place, well EMPLOYEE does in the end of the project, which is getting close, and I know about it, and the Superintendents out there and knows about and the Crew Leaders know about it. But then I change roles, the Superintendent's changes roles there is a real chance that it could fall over because you don't have those individuals looking over it and controls can't rely on individuals that need to be systemic." (Interview 2)

"It's more like the management of it. So it's the front line leader, how he managed it after I'd done the work. So whether they took that as a priority and/or they had something else that was more urgent to them." (Interview 3)

"If I had to pick a phase I'd say the hardest one is the Control phase… To stop regression so to confirm how that goes we will normally have a Validate gate review after a Control gate review. Just to have a look at is everything locked in." (Interview 6)

The Control phase has been identified as playing an important role because an organisations workforce is always changing. New employees will join and old employees will move roles into different Departments or leave the organisation altogether. The Control phase is important to ensure that the processes implemented into the project remain the same and the situation does not revert back to the issues identified before the projects inception.

The Case Study Organisation utilises what they call a "Validate' gate as sort of an extended control phase. Usually six to twelve months after the completion of the project, measurement and testing is undertaken to ensure that the implementation and controls put in place are operating as expected and the project has solved the problem that it set out to do. Only once a project has passed the "Validate' gate review can it be signed off as a successful project.

These findings are consistent with those identified during the systematic literature review during stage one of this research. The DMAIC methodology provides a structure to a project that gives the user a precise roadmap to navigate any issues a project team may face (De Mast & Lokkerbol, 2012), such as understanding the scope of the project or figuring out exactly what the primary metrics are to allow for measurement of success

5.4 Commitment

The concept of Commitment was identified as a factor that contributes towards Six Sigma Project success. Evidence of this was discovered in Interviews One, Two, Six, Seven, Eight, Nine and Ten, and Projects Two, Eight and Ten, in conjunction with all of the Senior Manager interviews.

Analysed data from the interviews suggests that commitment levels of Senior Manager's plays an important role throughout the life cycle of a project. The researcher identified evidence which shows

that the Case Study Organisation is extremely committed to assisting Green Belts and their projects, thus increasing the likelihood of the projects success.

As part of the define stage for a DMAIC Six Sigma project, the Project A3 (Project Charter) is completed. As part of the process a template is applied to measure and determine a 'Commitment rating' for the project. This rating dictates the level of commitment and support required to give the project the best chance of success. There are 12 sections requiring completion to calculate a final commitment rating. This is in the form of a weighted scorecard. The 12 sections are:

1. What is the main motivational drive behind this project? (enter as a %, the combination to equal 100)
2. Is there a HSE benefit?
3. What is the potential financial benefit of the project?
4. What is the sponsor's level of pain as a result of this problem?
5. Is it clear exactly how project success will be measured?
6. Confidence that the BB is determined to bring the project to a successful conclusion?
7. Is the process to be improved stable?
8. How stable is the organisation within the area(s) implicated in this project?
9. What is the sponsors knowledge and understanding of the process to be improved?
10. Does the sponsor know the historical background to this project?
11. Does the sponsor have the resources to be tackling this project at this time?
12. Is there a potential for "quick wins"?

A complete template is attached as Appendix 3.

Throughout every Green Belt training course, the Green Belt trainee is assigned a Black Belt as a sponsor or coach. Evidence strongly implies that this is to cultivate and foster a strong relationship between the two Belts. The ambition of this relationship is to provide

> *"Every trainee Green Belt gets assigned a Black Belt coach, to assist them if they had any issues, their first point of contact"* (Interview 10).

The Green Belts feel at ease approaching the members of the Business Improvement (BI) team as their first point of contact, instead of blindly ploughing onwards and possibly taking the project in the wrong direction. Direct evidence of these findings can be found in the quotes below.

> *"EMPLOYEE was my sponsor if I remember correctly, my trainer, yep EMPLOYEE was my coach."* (Interview 1, Project 2)

"It's about knowing that I'm available and approachable… so it's about getting off on the right foot and make sure we are aligned so we all understand what we expect to get out of this. And that they come for support or whatever. (Interview 2)

"We've come from a really good foundation and its always been supported and nurtured from Senior Management and that in part is due to the fact we've had really well selected projects and we've depicted significant value over the years……..But the candidates themselves... [Green Belts] they have a direct relationship with the sponsor or leader of that project... So I guess the sponsorship is quite key to supporting that process. (Interview 6)

*"At the time I'm also in what we call BI partnership… So the BI team, we're are all allocated a Department which we look at… so if someone out in the, well anyone that's part of the Assets team if they want BI support they can come to me,….That's what the sponsor is there for. Any additional resources, roadblocks, that's what your sponsor is there for, to get rid of. Generally they do that well, in my experience across numerous projects (*Interview 7)

"Yeah we had coaches we could go to…. Yeah we didn't like, with EMPLOYEE and a lot of other Business Improvement people we have on site, um certainly had plenty of people to go and talk to so that was good…. Yeah if I was to set into a big project now I would be like 'hmmm ok, I will actually go and talk to the Business Improvement guys' and go 'what do you think we should be using here and what do you know', instead of trying to bash my way through it, there are people there to help you know. (Interview 8)

"You've got a formal relationship with coach, we do also run during the training phase these public gate reviews. (Interview 9)

"That's what makes a Business Improvement team really valuable because you can dedicate 100% of your time to getting it completed….. So every trainee Green Belt gets assigned a Black Belt coach, to assist them if they had any issues, their first point of contact and also when they are running though, getting prepared for a gate review you run that through with the Business Improvement coach and make sure they have everything covered off. So the likelihood of success for each phase is higher." (Interview 10)

The leader of the Business Improvement team is a certified and experienced Master Black Belt who has the expectation that whenever a Green Belt is struggling with a project or requires some form of assistance, the Black Belt assigned to oversee the project will take immediate action and assists in any way possible.

"So the formal program that I have is I expect the Black Belt to be coaching all the Green Belts and I expect them to make time available at the drop of a hat. So if they're working on

a one million dollar project and a Green Belt asked them for assistance I expect them to drop what they are doing and help the Green Belt." (Interview 6)

"I guess the other thing that's key to a projects success would be tenacity. So a lot of people when they hit a stumbling block they tend to give up. The Black Belts we have a tenacious. They will take a problem through to solution. They will keep hunting and looking for a solution for a pathway and we try and coach out green belts to do that's as well." (Interview 6)

The commitment towards these projects continues up the hierarchal ladder all the way to the General Manager. As part of the Case Study Organisations procedures every six weeks they conduct what they term a 'gate review'. The purpose of this review is to ensure that the work undertaken in that stage of the projects lifecycle meets minimum criteria for success. Additionally the gate review provides the Project Leader with critical review, suggestions and recommendations for additional project work at that stage should it be necessary. All projects must pass a gate review before they can progress to the next stage. Attendees of these gate reviews include Managers, Sponsors, Green Belts, Black Belts and the General Manager. The gate review for each of the DMAIC phases has a unique checklist to ensure consistency, criteria for success is met and checking that the project is on schedule. Examples of these checklists can be found in Appendix 4.

*"So the site gate reviews [are] all the Managers are invited, all the Sponsors and all the Belts (Green and Black) are invited. So we have those every six weeks and last year we were struggling to get people along. Well, Green Belts that have a project sponsor that is engaged in DMAIC is more likely to succeed." (*Interview 7)

"You've got a formal relationship with coach, we do also run during the training phase these public gate reviews. So that's where we get a selection of the Belts come and present their project…where someone is stands up the front, in front of the GM [General Manager], their Manager, Superintendent, their peer group." (Interview 9)

The fact that all these persons allocate time during their day to attend these gate reviews displays the level of commitment that the Case Study Organisation has towards their Green Belts and the Six Sigma projects that are undertaken on site. During the time the researcher spent at the Case Study Organisation he attended one of the gate reviews where three Green Belt projects were presented which were at various stages of the DMAIC methodology. This gate review was attended by the General Manager and at least two members of the Senior Management team, as well as other Department Managers that had an interest in projects that were outside their inherent Departments. All Project Leaders were questioned by the General Manager and the project Sponsor about the tools and strategies they used during the stage of the project they were presenting. Additionally, each

Project Leader was offered advice by other employees present at the gate review. This demonstrates significant levels of commitment, purely for the fact that these people present at the gate review had no vested interest in the project, but still wanted to share their thoughts to help the project succeed.

It is the belief of several of the Senior Managers that commitment levels still need to be a higher focus within the organisation. This is because there is the belief that having a Leader or Sponsor who is heavily engaged and aligned with DMAIC plays a huge role in successfully completing projects. Generally, those Green Belts that have Black Belt coaches or Sponsors that have high level of engagement tend to complete more Green Belt projects than other trainees.

> *"So if we are going to go with the Six Sigma route then things really do start to fall quite heavily on the Sponsor and Leader on how well they keep them to that, get the gate reviews at the right time….I think quite a big factor is the quality of sponsorship we have… "Yeah and we have put in a lot of effort into the Belts, but in my opinion not enough effort into the Sponsor."* (Interview 9)

> *"So when I say engaged there are some Managers and Superintendents that have been part of the Business Improvement team or Green Belt, Black Belt trained themselves and passionate about it. Their Greens tend to succeed and tend to do a lot more projects that other Green Belts... but definitely you get a better results when you have a Leader or Sponsor who is aligned with DMAIC."* (Interview 7)

These findings from the interviews are consistent with the findings discovered during the systematic literature review.

According to Sin et al., (2015) 'Commitment' was ranked high on the list of factors that should be considered when looking at project success as the majority of business decisions will be top down decisions.

Additionally, Managers have the ability to create and cultivate environments that enhance both Six Sigma project success but additionally program success. *(Carvalho et al., 2016; Choi et al., 2012; Sony & Naik, 2012).*

Managers that choose to adopt Six Sigma into their organisation should be wary about how long tangible benefits might take to become apparent (Swink & Jacobs, 2012). For example Project Three progressed slowly over a total of 36 months due to various issues which included an extensive data collection over a period of 24 months. During this time all members of the Project, the Sponsor and Coach included remained committed to the project success until completion.

5.5 Measurement Accuracy

Evidence from the interviews indicates that the notion of 'Measurement accuracy' is believed to be a factor that contributes to the success of the project. The importance of measurement was brought up in five interviews with emphasis on the importance of accurate measurements. These accurate measurements play an important role throughout the project as they are crucial to the primary metrics and determining the level of success of any given project. Quote from Interview Six below provides evidence of this.

> *"It's absolutely essential that you understand what the percentage of variation in your measured outcome is coming from your measurement phase... Often people think it's good enough, but they find they can get the difference in the outcome so they have to go right back to the measure phase."* (Interview 6)

A secondary benefit of the measurement phase is analysing the data collected to determine how severe the complication or issue is.

> *"We got into a project and through the measure phase, and generally start analysing the data and actually find this project isn't going to address the issue, because now that we've measured we've realised that what we defined is different to where we're at."*(Interview 2)

> *"There were some questions around the processes, but we got that resolved during the measurement phase… That was based on, we did a number of tests for each of the steps and from that you get the standard deviation and can calculate the measurement systems…And they [employees] end up solving a problem you weren't actually looking for... And moment when you do the measure phase you realise the problem isn't the problem you though it was, it's a measurement issue… essentially because the project isn't there because how we are doing the measurement is the perceived problem."* (Interview 10)

There is a very real possibility that the problem that you think you are solving is actually not the root cause of the issue. It could simply be attributable to an error in the measurement system. However, it is imperative that during the Measure phase that it is completed in a systematic and stepwise manner, as seen from the evidence taken from Interview 10, Project 10.

> *"We were very confident because we broke each step down into what the measurement error was for each step in the process."* (Interview 10, Project 10)

One method of completing this step with the smallest chance of error is to ensure that the testing is replicated as closely as possible each time a new test is attempted. This was evident from Interview 3, Project 3.

> *"We had three Operators involved in the measurement. But using those guys each time for driving the design. So we collected baseline data with them and also then did the final trial with the new design in there." (Interview 3, Project 3)*

Only once the Measure phase has been completed and the Project Leader is confident that all tests have been completed to a satisfactory level, can the project then proceed to the Analyse phase. This confidence in the data collected allows the Project Leader to complete the Analyse phase and continue with the project. If the project is deemed flawed from a faulty measurement system the Project Leader, with assistance from Black Belt coaches or Sponsors must make a decision. Should the project be terminated and revisited at a later date? Or is the project salvageable with some minor alterations?

This was evident from Interview 8, Project 9.

> *"That was during the Measure phase….It was in the Measure phase before we go to the Analysis. So then I built a new measurement system and we got it a lot better."* (Interview 8, Project 9)

This finding regarding the importance of accurate measurement systems is consistent with the theories and evidence taken from literature. Cox et at., (2016) recognised the importance of a measuring device's ability to provide consistent measurement data for any organisation. As evidence from the interviews accuracy plays a vital role in any project but also for the organisation operating in a competitive market. The ability to detect and react to a weakening process has been shown to provide an organisation the opportunity to operate at a higher rate of competitiveness (*Shafer & Moeller, 2012).* This is due to the organisations ability to recognise these issues early on, preferably before they develop into a complication that will affect the organisation on a grander scale.

SPC (Statistical Process Control) charts are often used to provide visual information regarding whether the process variation or measurement system is in control. The SPC chart below in Figure 5.3 depicts an actual control chart being utilised within the Case Study Organisation, informing the user that the process being monitored is either in or out of control.

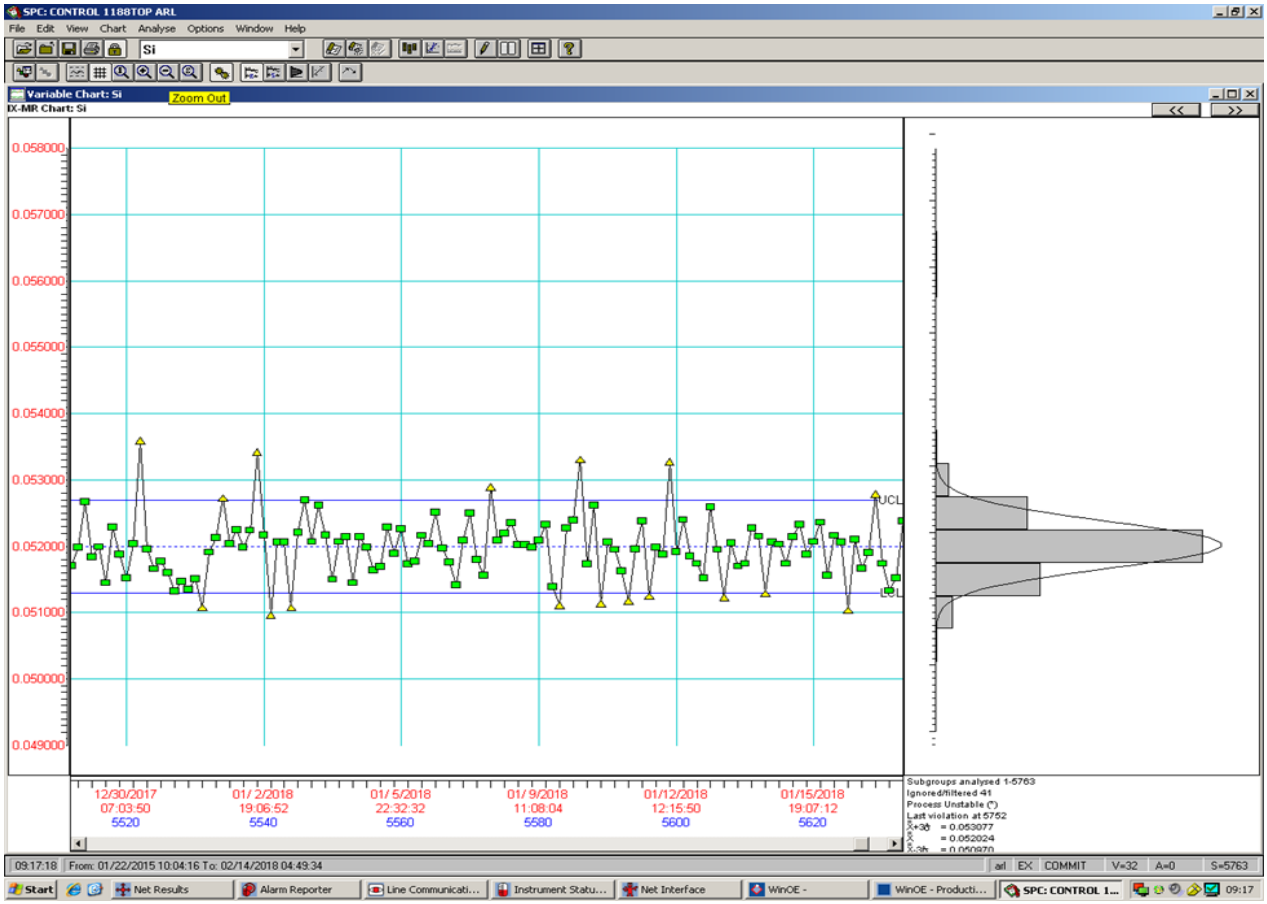


Figure 5.3: Statistical Process Control Chart. Obtained from Case Study Organisation.

This finding is important for any organisation as the organisation could assign the incorrect amount of resources or effort towards a project. There is a very real possibility that the dilemma at hand may not be a serious as first thought, alternatively the problem might be graver than first thought due to inaccurate readings. By ensuring that the problem is well known and thoroughly understood the organisation can limit the amount of non-value adding resources committed to the project and assign them more efficiently somewhere else within the business.

5.6 Resource Allocation

The notion of effective resource allocation, combined with benefits of efficient utilisation of any resources at the projects disposal was identified in a total of seven interviews ranging from Projects Three, Five, Six and Eight and two separate Senior Managers.

In several projects it was simply a matter of utilising the resources available at the immediate disposal and in others, it was a matter of allocating additional resources to engage external Consultants and/or expand the workforce to improve the project's odds of success.

Interviews Three, Four, Five and Eight identified the importance and effect of utilising the entire workforce as a means of effective resource allocation. Projects Three, Five, Six and Eight all sought out to take advantage of the employees that were potentially available. This strategic move had a

significant impact on the success of each of the projects in question. Evidence of this can be seen in the quotes below.

> *"Resource wise the guys that actually participated in the fishbone and some of the project were utilising because they had an interest in it. …. having the team do the fishbone diagram, coming out with the information... the four crews outside the team that did the fishbone."* (Interview 3, Project 3)

> *"So you know you need to get your experienced team, your experienced engineers saying 'yep we think that too' to get a voting system and go forward with that …So just having the resources, the availability and acceptance of the project."* (Interview 4, Project 5)

> *"I consulted with the medical centre, and they forwarded some of those resources onto me…. You can go to OHS [occupational Health and Safety] and type in musculoskeletal injury' and it will show you heaps."* (Interview 5, Project 6)

> *"Getting that team of guys together, their knowledge and we were able to jump basically, jump a lot of Analyse (phase)... We used them, we had an Operator there and then we had "Maintainers that maintain the piece of equipment and they had recently been inside... done the inspection"* (Interview 8, Project 8)

As mentioned previously, combined with evidence of internal resources the interviews provided evidence that the organisation was willing to spend additional effort and money on bringing in external Consultants as another form of resource allocation. These extra resources provided the projects with a simpler pathway to success as it allowed the projects to continue steadfast towards its objectives. Evidence of this can be found in Interview One, Project Two and Interview Two with a Senior Manager. Documentation of this finding can be found within the interview responses below.

> *"Who came over here to do some trials, because he was the expert, the inventor? For one of a better word. And we paid them to come over here for a week to do some trials…., using our PROCESS, and then we did one trial run at the end of it using their recommended parameters and that all went very well, the results of that were very good"* (Interview 1, Project 2)

> *"And that they come for support or whatever. ...if I can't do it myself, then I'll get onto one of the other subject matter experts and get them to provide support."* (Interview 2)

The organisation should not be hesitant of committing additional resources to a project. However, it should be noted that the cost/benefit of administering additional resources should be positive.

> *"If the team capability does not match the level of the problem throw some extra money at it. Don't waste time squirreling away"* (Interview 9).

If a project is starting to stall and becoming stagnant additional resources potentially may get the project moving in the right direction once again.

Evidence obtained from the systematic literature review is consistent with the findings from the interviews. Arumugam (2013) noted that resource allocation methods were positively related to a project success. Every project should consist of and have access to, the resources that grant it the opportunity to capitalise on any contingency providing the highest degree of success.

This concept of efficient resource allocation is important for an organisation to understand, as possessing the right level of resources required to complete a project is vital towards its success. Skimping on the appropriate resources required will very likely attribute towards the failure of a project. As the common saying goes 'You get what you pay for'. Higher quality resources and higher amount of resources provides the Team Members with every advantage, therefore providing the highest chance for a successful result.

5.7 Knowledge & Training

The concept of knowledge stemming from training levels was identified as a factor that contributes towards the success of a Six Sigma project. Evidence of this finding was apparent in Interviews Five, Six, Seven, Nine and Ten. This also included Projects Six and Ten and interviews with three Senior Managers.

Evidence from the interviews, particularly Interviews Five and Ten, indicates that in Projects Six and Ten an importance of utilising a collective knowledge at the Project Leaders disposal was crucial. Evidence of this can be found in the Interview quotes below.

> *I think at the time, I went and talked to each and every team so that was a significant investment. Listed a bunch of stuff from the Team themselves. So that provided a fair input. But I don't think is wasn't from all Teams. It was more like the Leaders and Team Reps. ... we also created a survey which went out to all, so the opportunity was there for each member.* (Interview 5)

> *"Well I guess EMPLOYEE [knowledge/experience] was pivotal because she had to know the systems they were using and provide me with the measurement system errors for each of the steps in the process so we could actually understand if we are getting a 4th decimal, what is the measurement error of the 4th decimal place? Because there is no point doing it if it's a 3rd decimal place.* (Interview 10)

This indicates, as with experience, the workforce and workers herein can be utilised and their collective knowledge drawn upon to assist with any project.

The Case Study Organisation was unique in the fact that they had the capabilities and financial resources to train their own Black and Green Belts on site. Importantly, the Case Study Organisation employed a Master Black Belt that has the knowledge, skills and certification to train Black and Green Belts. This provides the Case Study Organisation with a very unique competitive advantage in that they do not have to send employees off site and away from their regular duties for training.

> *I think we are quite lucky here because we are fairly autonomous. Which means we can effectively train our own Green and Black belts on site, with no external parties.... Yep so we've got the champions and I'm also the only Master Black Belt in the southern hemisphere for ORGANISATION…..So I guess we are quite lucky on site because we are fairly autonomous. We have quite a number of certified Black Belts. We can actually do the training ourselves. I do get some of the Black Belts training Green Belts themselves."* (Interview 6)

> *"EMPLOYEE basically leads it, with Black Belts taking modules. So I've taken a couple of modules during my training, the next Green Belt [training] I think is going to be in CITY and I'm not sure who will be taking that."* (Interview 10)

The Case Study Organisation recognised that just attending the training modules (2 x 5 days) was insufficient to ensure that the Green Belts stayed on track. As noted in Interview Six the Senior Managers thoughts on training were:

> *"In my view the training on its own is useless. It's only when the people get out to the field and apply the tools and framework does the learnings get locked in."*

This in conjunction with the Senior Managers perspective taken from Interview Nine;

> *"well I think if we out them in a position where they have to use it when they come out of the training and practice the skills, then hopefully they get some of them leaving like 'I've done all this work, but my measure phase was inaccurate, now I can't tell if I've made a difference' would be a common one.... They are going to be stronger at the end of it because they have practiced it more frequently and they have been able to do it in sizes that are not too diverse and complex that we can never see if we get anywhere."*

This tells us that it is the belief of the Senior Managers and Trainers that the tools and skills learned throughout the Green Belt (and Black Belt) training must be cemented with real world experience. This is achieved be ensuring that the skills and lessons learnt are put to use in real world experiences and projects. An example of this is the fact that each Green Belt trainee is assigned a Green Belt project to work on in conjunction with their classroom training. This is described in Interview Six:

"*Also the other thing that's important with that is we ensure the Green Belts have a project going into the training, so the Green Belt can progress the project through the training."*

Incentive and motivation to complete Green Belt (and Black Belt) training and projects originates from a time frame that Senior Managers place on the trainees to complete their certification within a 12 month period. This creates more of a pull system rather than a push system when it comes to Black Belts assisting with Green Belt projects, making sure that the projects being worked on are undertaken alongside a trainees regular work duties and they receive a financial incentive to complete certification and projects. This is described in Interviews 7 and 9.

"For Green Belts you were expected to get your Green Belt certification by that 12 months… When people have that driver behind them it works really well. The pull system became a bit of a push system, because the Business Improvement team still had it in our performance management system, but the Green Belts didn't have it in theirs. So this year we have created, it's hanged again as its back in their performance metrics and we are getting that pull system working again. Then when I am coaching I can coach whatever they need support with. It can be any of the DMAIC steps." (Interview 7)

"In the past few years we have linked certification to their salary. So if you want to get paid as well as you possibly can, you need to follow through with that certification work... So the current wave is a little bit disconnected. But as the year goes on, at the end of August they haven't been certified then that are starting to lose money out of their new pay increase...I personally think that what will drive the pressure at the end is that salary implication. You know EMPLOYEE charts the number of people being certified each year, when we did that we got an 'out of control' point... my accountability is to the Black Belt team and Business Improvement team, and what we find is that people that get certified quicker are more receptive to the coaching, they are making progress faster and over all need less support from the business improvement team because they get through and done." (Interview 9)

*"The difficulty with some of the Green Belt trainees is that some of them see their project as an addition to their role rather than a part of their role. So when they start seeing that as an addition to their role rather than tools to get their job done, then often the progress on their project slows, as their day to day workload is so high." (*Interview 10)

The Green Belt training provides a multitude of tools that a Green Belt can use in projects and in the routine day-to-day work. However, not all tools will be used for all projects and this is the part of the coaching that the Black Belt provides to the Green Belt, - which are the best tools to use for the project. Two Interviews provided very good analogies to articulate this idea of ensuring the training incorporates which Six Sigma tools are best for a given situation.

"That's where the coaching program is essential as well. A lot of the Black Belts we have are seasoned veterans. They are used to that, they know how to get people out of that. Quite often if you're in a thick forest at night with no way to see out. One of the tools you might give someone is an axe. Start chopping trees down and make a bit of a clearing. That's how I see the Six Sigma tool set. It's all about providing those tools and guidance to get those people out of the forest. Because once they are out of the forest they can actually solve that problem." (Interview 6)

"So we have a couple of tools that we recommend. So that's the use of a parking lot. So a parking lot is people will normally get an idea and want to spend a lot of time on it, but it might be irrelevant to what work you're doing. So it gets put in a parking lot to hold it somewhere so it doesn't derail the discussion that's happening.... they are involved but their involvement is often to tear ideas down." (Interview 6)

With the Project Leader playing such an important role during a project it is understandable that an organisation will go to great effort and cost to ensure that the individual will be trained to have the necessary skills and competencies required to supplement their experience. For this reason many smaller businesses cannot afford to maintain a steady Six Sigma program due to the cost and resources required to keep such a program operating to a high capability standard. For example in New Zealand training for a single Green Belt can cost up to NZ$5,400 for a five day certification course (*Lean-Six-Sigma-Training-Courses. n.d.).* However, the Case Study Organisation undertakes their own Six Sigma training in house at a quoted cost to train a Green Belt of approximately $10,000 for a two week course with certification only granted after completion of two projects. If an organisation wished to progress Six Sigma training further and invest/recruit a Black Belt the training is significantly more expensive with the Case Study Organisation quoting approximately NZ$15,000-$18,000 for a three week intensive training course which is accompanied by further on the job training requiring completion of two Black Belt training projects. These training costs are thus a considerable investment by the Case Study Organisation which has 39 Green Belts and 18 Black Belts within the organisation.

These findings from interviews are consistent with finding from the literature. Knowledge and training are sources of competitive advantage for an organisation as they help provide value to the organisation and allow the organisation to be ambitious in the market (Choi et al., 2012), and should be seen as an investment, not an expense against the organisation, as the skills learnt through the training are deemed as necessary to run Six Sigma projects (Sin et al., 2015; Shanmugaraja et al., 2013).

Training is an essential factor for implementing change within an organisation (Sony & Naik, 2012) so therefore observing a connection between these literature findings and examples from the Case Study Organisation is consistent with other findings in this research.

5.8 Leadership Experience

Evidence from the interviews indicates that experience is linked as a factor that contributes towards a project success. This experience is not limited to the level of leadership experience that the project leader holds i.e. Green Belts, but also the experience of Black Belts that were assigned to the project as either a coach or as a sponsor. Additionally, all members of the organisation were also identified as holding a significant level of experience that could contribute, either from an operational perspective or from a systems knowledge perspective. Analysis from the interviews revealed that in three separate interviews (Interviews Five, Six, Eight and Projects Six and Eight), that experience proved valuable to the success of the projects. This was also supported not only from interviews of project members but also from the Senior Manager's perspective. Interviewee's speaking about their individual projects were quoted.

> *"I went and talked to each and every team so that was a significant investment, Listed a bunch of stuff from the team themselves, so that provided a fair input."*(Interview 5, Project 6)

> *"we really started talking about what was going on and started to gleam some knowledge from other people, from tradespeople and things and that was sort of an aha moment, a lightbulb moment you know."* (Interview 8, Project 8)

This can be additionally paired with the Senior Manager's thoughts regarding the calibre of the Black Belts on site:

> *"That's where the coaching program is essential as well. A lot of the Black Belts we have are seasoned veterans. They are used to that, they know how to get people out of that."* (Interview 6)

These three individual quotes from three separate individuals' indicate to the researcher the importance and the level of reliability that the Case Study Organisation places on the experience of both the Black Belts and the knowledge of all members of the organisation. This finding is consistent with literature regarding experience that was uncovered during the systematic literature review of this research. The literature indicates that "*Clearly, the experience that a team leader has leading projects goes a long way in improving the odds of a Six Sigma project success….The team leader is probably the most important facilitator in terms of driving a problem solving (*Easton & Rosenzweig, 2012). Organisations should be aware of how valuable their workforce is as a resource. Projects Six and Eight, demonstrate that the Project Leader should seek out the experience of those with more experience with the problem.

Experience can be a very attractive attribute of any employee because experience is something that only comes with time, invested resources and effort. For example from Interview Nine with a Senior Manager, the researcher learnt that experience is very attractive towards recruiters.

> *"I occasionally take phone calls from recruiting agencies saying 'oh EMPLOYEE, have we got the job offer for you' kind of thing. I've done a decade as an engineer, I'm a chartered professional engineer, and I've done all these professional roles. Most of the phone calls I get, the only thing people are asking about is my Business Improvement experience."*
> (Interview 9)

Within the Case Study Organisation the average length of service of employees is approximately 18 years with greater than 150 employees having greater than 30 years' service. It was very evident from interviews and empirical findings the Case Study Organisation leverages significant value from experience of employees by utilising this experience throughout business improvement activities.

Thus, organisations utilising Six Sigma should be aware of how valuable experience is and how it provides a significant source of competitive advantage. The organisation should ensure they continue to retain experienced employees within their workforce.

5.9 Employee Acceptance

The major finding of the research was the discovery of a success factor that was not discovered or found in the systematic literature review. This significant finding is how 'Employee Acceptance' levels play a part in the success of a project. Evidence from the interviews revealed the concept of 'Acceptance' when participating, leading or completing a Six Sigma project. This concept was the most frequently described factor which contributes to the success of a Six Sigma project or program. "Acceptance' was attributed as a success factor in Interviews One, Two, Three, Four, Six, Seven, Eight, Nine, and Ten. These interviews included every single project excepting Project Five, and was included in every interview with Senior Management.

The major focus points discovered as a result of the interviews at the Case Study Organisation were:

- Importance of gaining employee acceptance,
- Examples of gaining employee acceptance, and
- The equation: $\text{Results} = \text{Quality} * \text{Acceptance}$ (R=Q*A)

Importance of gaining acceptance

From the interviews the definition of 'Acceptance' can be described as everyone involved with the project having a feeling of invested effort, ownership or seeing the benefits of the final solution. The definition was created using notes from the Interviews such as

"*Yep it's about everyone feeling they have ownership. Feel like they can contribute and everyone feels like they are being listened to and they can see and trace their idea through the process."* (Interview 6)

"I think people understood what we were trying to achieve, so we had a good opportunity statement, it met the business benefits that we were looking for and we had the buy in from the people that were making the changes" (Interview 10)

Acceptance is vital to a Six Sigma project because:

"*Although I've made the change, put the systems and tooling in place, the guys are the ones that do the work…Because if you don't have the acceptance of your crews then nothing's going to work, it might be a great idea, but if they're not on board they're not going to do it."* (Interview 3)

Without the acceptance of the people where the proposed solution or product is set to be implemented, the project is likely to be rejected and therefore cannot be classed as a success.

While there is likely to be hundreds of differing methods for gaining acceptance rates, from the interviews we see specific examples of how the Case Study Organisation gains acceptance.

"We canvassed all the opinions and went through each crew and asked their opinions on where we think we should go, what the potential roots for improvements were and they were quite clear what they though the root was" (Interview 1, Project 1)

"When you go out and ask people, so what's the cause, everyone's got a different view and how it might be." (Interview 2)

"What went well was the buy in from the guys actually. From the team after we did out Fishbone actually….. I approached the Crew Leader to select people in their crew that would, um, like to participate in it. Obviously you want people that want to do stuff, not people that have to do it. But you also want to chuck someone in there, generally I look at people I want to put in there.... you want people there that are going to challenge you and put it out there…..... having the team do the fishbone diagram, coming out with the information... the four crews outside the team that did the fishbone." (Interview 3)

"Resource wise the guys that actually participated in the fishbone and some of the project were utilising because they had an interest in it." (Interview 3)

"Because in the end it wasn't just one Department it was three Departments with four different Crews all working together in one sort of process, so that was a success." (Interview 4)

"Yeah so from the team launch, we really started talking about what was going on and started to gleam some knowledge from other people, from Tradespeople and thing and that was sort of an aha moment, a lightbulb moment you know... So the Team launch was quite valuable in this case… So quickly you know, the guys in that team launch, um, we sat down and talked about it and were like 'well these blowers (the hoses) are worn though so the air slides aren't running properly and it's the material and it's blowing dust everywhere…We had a lot of buy in from the, um, Operators. They were really good and really supportive you know because it was obviously... they were quite excited that someone was actually showing a bit of interest and trying to do something"…."We had a lot of buy in from the guys because it's another frustrating task for them so they were right on board trying to help me." (Interview 8)

This evidence from the interviews shows examples where the Project Leader has approached employees of the organisation for assistance. These employees are the people that have been affected by the issue or problem and are providing vested interest in the success of the project, the main workforce that will be operating or be implementing the project solution in their workplace. If they don't accept the solution the project will fail. Additionally, employees have the opportunity to contribute even though the project solution may not affect their immediate workplace.

The researcher has observed that to ensure employee acceptance and thus project success there must be a belief of Senior Management or Project Sponsors that there is a need for change. Without this belief there it is unlikely they will provide the commitment necessary for rom project inception to closure. Furthermore, those who will be most affected by the project's completion (i.e. project stakeholders) must also recognise that the project is worth undertaking and will provide value to the organisation and to themselves.

Employees impacted by the project will be asking themselves 'what do I stand to gain from this project'. Similarly, to believing there is a need for change, they must also have an understanding of how the project will affect them and their work environment.

The Define stage of the DMAIC Methodology is the place best suited to beginning the process of gaining employee acceptance. Involve the employees early, as this allows them to air their grievances and concerns so that they can be addressed promptly.

Senior Management and the leadership of a project must be transparent throughout the Project life cycle. This maintains trust and respect between all those involved.

This acceptance ideally should be cultivated right from the beginning stage, i.e. right from the Define stage of the DMAIC Methodology. As described in Interview 10:

"*You really have to get the team involved right from the start, so they have that acceptance. Otherwise it will fail even if it's the best solution in the world."* (Interview 10)

*R=Q*A*

The Case Study Organisation have created using their experience of Six Sigma programs the equation R=Q*A. That is that the 'Results' that a project will deliver are a product of the 'Quality' of the project itself, being the improvement solutions proposed, and the 'Acceptance' of the proposed solutions within the workplace.

Theoretically if a project quality was calculated as 10/10, however if there was minimal acceptance at a rating of 1/10 then the overall result would be 10*1=10

However if they quality of the project was judged lower at 6/10, but with higher employee acceptance rates of 8/10, then the overall project success rating would be 6*8=48

From this it can be seen that employee acceptance provides a significant contribution towards a projects success.

This saying of 'R=Q*A' is a fundamental factor within the Six Sigma program to deliver project success and thus business value.

> *"So the most important equation we use in Six Sigma training is R=Q*A ….Results, quality of work and acceptance. So that is the most important equation we have in Six Sigma. We pound that from day one, because you are right, it is much easier to change an accepting person than someone that is resisting"….* (Interview 6)
>
> *"You need R=Q*A. Results = Quality and Acceptance."* (Interview 7)
>
> *You know R=Q*A. People are really good at Q but crap at A, if you do a brilliant solution but can't get the A then you're going to get great acceptance for a poor quality solution as well.... this might be done by teaming up with someone who is, or getting the right kind of support"* (Interview 9)
>
> *"EMPLOYEE would have said this before. The results you get from any project is the quality of the solution"* (Interview 10)

5.10 Summary

This chapter introduces the findings collated from the interviews in order to answer the research question: *How do contextual factors of a project account for Six Sigma project successes or failures?,* before putting forward the most significant finding of the study which is a critical success factor that was not identified in the systematic literature review. This critical success factor was employee 'acceptance'.

The chapter then proceeds to present further information regarding the Case Study Organisation that was uncovered during the interviews. This additional information includes the proven benefits of the Six Sigma program at the Case Study Organisation, it's implementation of the 'DMAIC everyday'

program, its reliance on the Project A3's and strategic decision making process leading to the strategic project selection using the benefit-effort matrix.

This chapter then advances to the main section by connecting the critical success factors identified in the literature with evidence found in the interviews.

This starts with project structure and the importance of the Define and Control phases. Define being important as it is this phase where the project scope, goals, key metrics and problem are fully understood. Additionally the Control phase was identified as significant as the workforce of an organisation is forever changing and evolving. Controls need to be put in place to ensure standardised training is put in place to ensure the flow of knowledge does not end. Furthermore the control phase is important to protect the gains of the project once the project has been declared finished. This is extremely important to make sure that the situation does not revert back to its critical state from before the project was commenced.

The next critical success factor that was identified was the factor of Commitment. The importance of Senior Management commitment throughout the project, with examples being provided of the site wide gate reviews where Senior Managers attend to track the progress of all Six Sigma projects on site. The emphasis and benefit of the commitment rating that is applied at the beginning of the project. This commitment rating outlines the necessary level of commitment that is required in order for the project to be successful. Finally the Black Belts commitment to training and coaching for the Green Belt trainees.

The next critical success factor that was identified was the seriousness of measurement accuracy. The researcher discovered evidence that measurement accuracy is crucial to identifying primary metrics of a project and determine the level of success of the project. The second benefit of measurement accuracy exposed was the ability to determine exactly how severe the complication or issue actually is. This finding is meaningful because the project problem might be either worse than or simply not as serious as first thought, and the project may be heading in the wrong direction or not addressing the problem at all. This finding of the importance of measurement accuracy identified by the researcher is importance because accurate measurements is crucial during the measure phase of DMAIC as the measure phase must be 100 percent completed with confidence before the project was advance to the analyse phase.

The chapter then moves on to provide evidence for the importance of efficient resource allocation. This was broken down into two areas: efficient resource allocation and utilising available resources, and allocation of additional resources to improve the odds of a project success. Examples of efficient resource allocation were shown using the workforce as one example as it is often underutilised. The workforce of the organisation is often a goldmine of information especially for employees who have been employed by the organisation for many years. Secondly, allocating

additional resources towards a project should be recognised as being a positive pathway to achieve project success. Evidence of the significance of knowledge and training was then presented. The importance of knowledge, more specifically the importance of the collective knowledge and training employees together and into the project was discovered to be significant to a projects success. Additionally training was identified as being a critical success factor, not just in literature but in real world situations as well. The Case Study Organisation is fairly autonomous when it comes to training Green and Black belts due to the Master Black Belt that is employed. Having the Master Black Belt on payroll is an immense benefit to the organisation as it provides a competitive advantage over other businesses in the market.

It was also identified that it is the belief of the Senior Managers that training is useless without putting it into practice with real world experience to cement the learning in the trainee's minds. It is important that that training is a pull system rather than a push system when it comes to the relationship between the Green and Black Belts. Green Belts need to be motivated and want to learn and feel comfortable doing so, rather than having the perception that Six Sigma and the training involved is a chore.

Following the importance of knowledge and training is the critical success factor or leadership experience. The researcher identified this is not only Senior Manager leadership experience, but also Black and Green Belt experience as well. Organisations should realise that all employee have some experience regarding something potential beneficial and that shouldn't be overlooked or under appreciated.

Concluding the main findings from the research is a major finding that was not identified in the systematic literature review. While all other Critical Success Factors were identified in the literature and evidence from the interviews corroborated those findings, the researcher did not find any mention of 'employee acceptance' in the systematic literature review. This significant finding of employee acceptance was broken down into three major subsections.

1. Importance of gaining employee acceptance
2. Examples of gaining employee acceptance
3. The equation R=Q*A that was promoted at the Case Study Organisation.

The importance of gaining employee acceptance to ensure project success was recognised by the researcher, creating the definition from evidence in the interviews for employee acceptance as: "*everyone involved with the project having a feeling of invested effort, ownership or seeing the benefits of the final solution*." Evidence suggests that increased employee acceptance leads to less likely scenario that the final solution will be rejected as if they [employees] don't have acceptance of the final solution then it doesn't matter how perfect a solution it is.

Examples of the Case Study Organisation gaining employee acceptance have been provided with approaching the employees for assistance, i.e. those that have been affected by the issue/problem and have an interest in the success of the project as being highly effective towards increasing and maintaining acceptance levels throughout an organisation. It was also noted that the process of gaining employee acceptance is best commenced at the beginning of the project [define phase] and nurtured throughout the projects life cycle.

Finally the equation R=Q*A was introduced as being significantly important. Throughout the Case Study Organisation, R=Q*A [Results=Quality of Solution* Acceptance levels] plays an important role in understanding and visualising how important employee acceptance is for Six Sigma project success.

The following concluding chapter of this thesis begins by summarising the purpose of the research and what has been achieved, phase one research methodology and findings and phase two methodology and findings. Additionally the chapter provides theoretical contributions and managerial implications of this research. The chapter then concludes with the limitations of the study and possible directions for future research.

6. Conclusion

6.1 Introduction

This concluding chapter will answer the research question that was formulated at the inception of this research study.

This Research Question is: *'How do contextual factors of a project account for Six Sigma project successes or failures?'*

This chapter begins by outlining the methodology followed, documenting the significant findings from each phase of the methodology, before definitively answering the research question. This chapter then presents the limitations of this research and possible directions for future research.

6.2 Research Question

'How do contextual factors of a project account for Six Sigma project successes or failures? "This research set out to answer this research question through a two staged mixed method approach. Stage one consisted of a systematic literature review of current and relevant literature. Stage two consisted of a series of semi structured interviews at a single Case Study Organisation.

6.2.1 Stage One: Systematic Literature Review.

Five research questions were constructed to ensure adequate data was collected from the systematic literature review. These questions were:

1. *What is Six Sigma?*
    - Six Sigma originated in the late 1980s at Motorola Inc. as a method of measuring defects and variation within a process, with the overall vision of increasing the quality of goods produced.
    - Six Sigma is a collection of statistical analysis tools and techniques, with the ultimate goal of reaching 3.4 Defects per Million Opportunities of goods produced.
    - At the core of Six Sigma is the DMAIC Methodology. DMAIC consists of five phases. These are in order; Define, Measure, Analyse, Improve and Control.
    - The DMAIC methodology provides a structure to a given project that should be followed in a step wise motion; i.e. a project cannot move onto the next phase without confidently completing the previous phase.
    - Similar to martial arts Six Sigma has differing levels of qualifications denoted by metaphorical coloured belts to symbolise the level of training received. These belts range from Yellow-Green-Black-Master Black Belt.
2. *When implemented effectively what gains does it give a business?*
    - Six Sigma provides a range of benefits including but not limited to financial savings, higher level of team synergy, increased innovativeness & higher job quality

- Six Sigma has been shown to be effective in a range of markets including healthcare, automotive, telecommunications, electrical systems and aerospace engineering.

3. *What does the literature say about the likelihood of successful implementation?*
    - This researcher has identified a range of Critical Success factors. These are:
        - Measurement accuracy: Importance of accurate measurement systems in order to provide reliable data to use when making project decisions.
        - Commitment: Importance of Senior Management commitment for the duration of the entire project is significant to the project's success.
        - Project structure: Importance of project structure with regard to problem solving methods and the notion that complex problem, DMAIC provides a well-structured roadmap to navigate any issue that arise.
        - Knowledge/training: Collective knowledge of individuals should be encouraged. There is potential for a higher quality solution when everyone's ideas are listened and considered. Training provides benefits to the organisation such as Belt certification that builds upon the existing knowledge base and ability to execute improvement work effectively.
        - Leadership experience: Team leader experience was found as a significant factor in the success of a Six Sigma project.
        - Resource allocation: It is important that managers provide the appropriate level of resources required to complete the project to ensure projects have the highest chance of success. An organisation should be willing to provide additional resources should it be deemed necessary to ensure Six Sigma program success.
4. *What evidence is there that Six Sigma has been implemented in New Zealand?*
    - This researcher has found limited academic evidence that Six Sigma has been implemented in New Zealand. Literature evidence shows that at least 34 organisations have implemented Six Sigma into their processes.
    - However the researcher discovered a range of organisations providing training for Six Sigma certifications ranging from Yellow, Green, Black and Master Black belts.
    - Job advertisements provide additional evidence that Six Sigma has been implemented in New Zealand as several advertisements over a range of websites list Six Sigma experience as a sought after quality.
5. *What is the level of reported successful implementation in New Zealand?*
    - The researcher found very limited evidence that provides a level of successful Six Sigma implementation in New Zealand. Similarly with literature question four, 34 businesses were found to be using Six Sigma, various training programs on offer and job advertisements seeking Six Sigma trained individuals.

- From these findings the research assumes that due to the supply of training regime and the demand of qualified job applicants, Six Sigma is has achieved a considerable successful implementation rate.
- However, the researcher should make clear that this is merely an assumption. No academic evidence is available to justify this theory. This provides an opportunity for future research.

6.2.2 Stage Two- Case study interviews.

The researcher identified a Case Study Organisation that had adopted Six Sigma and routinely used Six Sigma methodology throughout their entire business process for the past 15 years. The researcher selected and investigated a range of improvement projects which had used Six Sigma methodology and then interviewed multiple employees involved with these projects to gain understanding of which factors contributed to the success of the projects.

The researcher identified that there was significant increased business growth through using Six Sigma methodology. Findings in this stage of the research regarding the Critical Success Factors that contributed to the success of Six Sigma were consistent with the Critical Success Factors identified in the systematic literature review. These were:

- Project structure
- Commitment
- Measurement accuracy
- Resource allocation
- Leadership experience
- Knowledge/Training

However, in addition to the above Critical Success Factors found as result of the systematic literature review and the interviews at the Case Study Organisation, the researcher discovered that '**employee acceptance'** played a significant role in contributing to the success of a Six Sigma project at the Case Study Organisation.

In addition to information being identified in the interviews the researcher attended and observed Six Sigma gate reviews, the annual 'deep dive' planning process and weekly site business improvement meetings. Throughout the observation process there was a common theme that 'acceptance' of change was crucial to the success of the work being undertaken.

6. 3 Summary and Discussion of Findings

6.3.1 Theoretical Contributions

As with the majority of research papers, the expectation is to contribute into the collective knowledge that has previously been published. The findings of this research seeks to continue this tradition, by filling a gap in knowledge that was identified in the early stages of research planning. At the time this research was completed, the numbers of academic studies focusing on Six Sigma in New Zealand was relatively low. Examples of such papers are Corbett, 2011, d'Young, Young, Ockelford, Brasser, Slavin, Manson, & Preston, 2014 & Eliasm 2016). However, the specific success factors in New Zealand have not previously been investigated. The overall aim of this research at its completion is to contribute to academic knowledge by providing a valid and established knowledge foundation for any future researchers focussing their attention towards similar research.

6. 3.2 Managerial Implications

The outcome of this research is expected to produce a series of factors and/or business initiatives to ensure deployment of Six Sigma within an organisation is successful. Examples of these positive outcomes are demonstrated in examples with the Case Study Organisation and are attributed to a significant and enduring commitment from senior leadership as well as Six Sigma practitioners. This includes reliance and confidence that investment in a well deployed Six Sigma program will lead to additional business value. Six Sigma practicing Managers should be interested in reviewing the concepts presented and be able to identify a series of factors that they can focus on and foster within their own business environments. This knowledge would lead to a higher certainty that Six Sigma projects could be successful, both in monetary terms and in non-tangible benefits such as employee satisfaction from seeing that their improvement contributions are directly adding to business success.

6. 4 Implications of Study

Within the current literature there are studies that focus on Six Sigma usage and implementation on an organisational scale throughout the world (Antony, Kumar & Madu, 2005; Arumugam, Antony & Kumar, 2013; Carvalho et al., 2016; Chiarini, 2013; Choi et al., 2012; Easton & Rosenzweig, 2012; Krueger, Parast & Adams, 2014; Shafer & Moeller, 2012;Sony & Naik, 2012; Timans, Antony, Ahaus & Solingen, 2012). However, upon further investigation it was identified that there are few research papers that sought to focus the attention on the Six Sigma program and its usage and implementation within New Zealand (Corbett, 2011; d'Young et al., 2014; Elias, 2016; Ngo, 2010). Therefore, the findings from this research in the field of Business Improvement, and explicitly the success factors for Six Sigma projects, will contribute to both academic and practical areas of knowledge.

On an academic level, this research provides real world, empirical evidence of the theories found in academic literature. Evidence to support this claim arises from the critical success factors identified

in the case study organisation that corroborated the critical success factors identified in the systematic literature.

However, the major addition to academic knowledge is the finding of new areas of knowledge regarding the importance of 'acceptance' within a Six Sigma program and individual projects. The systematic literature review conducted as part of this research found no mention of the importance of placing such a high degree of importance for acceptance levels within a Six Sigma project

6.5 Limitations

While the literature review was systematic and focussed on obtaining evidence from A* journals, it revealed the volume of such research world-wide was not high. While the number of journal articles was small the quality of each ensured they provided useful knowledge. Only two journal articles were excluded because they were not published in English and the researcher did not having the ability or resources to translate them.

There was relatively less literature describing the implementation of Six Sigma within New Zealand. Only a small number of businesses were found to have implemented Six Sigma in New Zealand. This was the catalyst for choosing to undertake an in-depth study of one New Zealand organisation which has Six Sigma systems within its operational planning and execution for a number of years. The researcher was fortunate to have had open access to this organisation's business improvement projects and systems which arguably are at the forefront of maximising business value.

Findings from the Case Study Organisation that was conducted support factors for success identified in the extant literature that was reviewed. Furthermore, and most significantly, the case study identified an additional factor, 'acceptance', that was a major factor in Six Sigma project success.

6.6 Opportunities for Future Research

The opportunity should be taken to repeat this research, both within similar businesses in New Zealand and in Six Sigma programs in overseas countries, to identify if 'acceptance' is a major factor in Six Sigma project implementation and success within other organisations.

Additionally, the researcher recommends that further research includes investigations of business improvement programs and projects that do not use Six Sigma to see whether 'acceptance' is a significant factor in success of such projects.

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Appendices

Appendix 1. Semi Structured Interview Questions

Senior Management:

1. For my study I am looking at projects that specifically use Six Sigma methodology. Can you please outline your Six Sigma program? For example the implementation process and the projects that have utilised Six Sigma methodologies?
    a. Prompts: Motivation, whose idea, Driving factor, Successful? Training; who, what, where., how
2. I am interested in understanding the factors that contribute to the success of a project. Can you please explain what makes a project successful and why?
    a. Prompts: Management commitment, communication, freedom, training, measurement, resources
3. What aspects of problem solving and using DMAIC is challenging for teams?
    a. Prompts: Time frame, measurement accuracy, how important is a proper define phase- charter, scope extra
4. Can you comment on the team leadership, functioning and the support that you provide
    a. Prompts: Number of belts, time commitment, experience/projects completed.

Project Leaders and Team Members.

1. Can you please give me a grief background on the project?
    a. Prompts: who, what, why, when, driving factor, regular or critical (emerged as time critical), flexible deadline, how much time did you spend on the project.
2. To what extent was the project a success? Why?
    a. Prompts: did the project go over deadline, how do you know project was a success?- your thoughts or were you told?
3. What went well with the project? What else would have helped to further improve the working of the team and achieving the project objectives?
    a. Prompts: Knowledge, resources, experience, measurement
4. Have you used DMAIC methodology? I if so, what steps of did you find challenging? What were the positives regarding DMAIC? How did they contribute to the outcome of the project?

Appendix 2. Interview Analysis

Interview 1

Interview 1			
Project number	**Quotes**	**Thoughts/coding**	**Group/Category**
1	"Yeah well the whole project started um as a green belt training exercise."	Green belt project	Project Background
	"Had casting defects and we using the green belt project to try and us, analyse the defects and see if we could come up with a solution because it had been several years of looking at trying to fix it. ……..but they have high scrap levels."	Financially driven, due to rework.	Project driver: Financial
	"What we probably didn't identify in that case was that we only cast these products uh about once a month at least, with one or two casts. And at the time we were doing the green belt training it was 2 or 3 months between trials and for two casts was not enough to gather sufficient data because of the variability, so it ended up almost running a yeah. Um we tried to do some trials and eventually we just gave up and sort of said, "we cannot do it under the offices of a green belt project". Because it's very much going to be a trial and error kind of approach."	Killed off early	Project killed off early
	"we canvassed all the opinions and went through each crew and asked their opinions on where we think we should go, what the potential roots for improvements were and they were quite clear what they though the root was	Team input	Acceptance
	"But I was clear in my mind that that was a red hearing, from my experience."	Personal experience moved to the wayside	Project background
	"so this is where I don't like green belt because it takes away some of the experience and knowledge of your champion and relies on group problem solving and sometimes group problem solving doesn't work"	Negative of six sigma project	Six Sigma disadvantage
	In response to what worked well with the project: "Not a great deal, the only thing that went well, I mean it introduced me to some more green belt tools, which is the only thing I've got in favour of six sigma from a personal perspective, is some of the tools that were implemented were quite useful and they make my life easier use them every day rather than just green belt projects."	Benefit of Six Sigma, everyday tools	Six Sigma benefit

	"No it didn't reach its target, we decided effectively that um, the constraints that we had, the final conclusion that we had, the final conclusion came that many of the problems were chemically related…. We decided that there was going to be a high scrap that we get from PRODUCT to the next and it's a good PRODUCT to do that, and we just have to factor in the fact that scrap is going to be twice as high as other products..... I think it was a case of we could have fixed the problem, but the constraints would have had so many knock on effects that it would have been detrimental to the overall um, profitability of the department."	Killed off. Didn't reach original objectives, but this was accepted as alternative would be detrimental to the business.	Project killed off early
	In response to asked out of all the DMAIC steps, out of all the different phases, what would you say was the most challenging or difficult: "I think the scope was ok, the measurement was ok? It's the analysis and improve, certainly the analysis phase, because we had a limited amount of data and we had a lot of variation....we even though we know really where the problem lie, there's not really a lot that we can do to improve them because of the other constraints. "	DMAIC process. Analyse and improve were the most challenging with this particular project.	Project structure (analyse and improve)
	*Response when asked about the success of the project: "*I think there's a summary on here, we left it at something at like 15%. We did get improvements, there were improvements and left the methodology of getting improvements there…. It's a success in a way that we understand that the problems were causing the issue in the case are known, well at least most of them are known."	Not a total failure. Still provided valuable information should a future project is needed.	Project success
2	"we decided, we, this was never started as a green belt project, This was just started as a run of the mill project, um, although I did follow the DMAIC guidelines because I do that naturally, and this one was shoehorned into a Six Sigma project essentially because I needed it for the training. .....we did follow the Green Belt DMAIC Six Sigma methodology throughout the project, so it was very easy to just massage all the stuff, we had all the right templates.	Didn't start as a Six Sigma project. However DMAIC was followed informally.	Project background
	"Supplier came to us and said 'we have a much higher quality product for you and we can give you cost savings reduction in usage of 80%'.... We counted $200,000-$240,000 saving."	Financially driven	Project driver: Financial
	"And then we got an external company to come in and do some trials for a week just to demonstrate everything was, um, up to that standard, and that basically then at that point the Six Sigma project came in."	Resources required. Outside resources brought in to help project.	Resource allocation

	"From an implementation point of view it's been a success in many ways, we have had equipment success, we put in new equipment un to handle this product in a better way and that's given us benefits, um we have health and safety benefits have come out of it because less handling of the materials down there and uh, we have the costs savings on usage."	Successful project	Project success
	"EMPLOYEE was my sponsor if I remember correctly, my trainer, yep EMPLOYEE was my coach."	Upper management commitment	Commitment
	"well we um, we had the benchmark figures on there for the reduction in the amount of PRODUCT usage without an increase in scrap levels of anything like that, and the fact that we could have exceeded them, um, but we reached those targets, certainly from a production perspective, with no noticeable issues at all, we did lots of sampling, we do scrap analysis anyway and we've still not found any indication.... level was at a significant reduction."	Successful project	Project success
	"Who came over here to do some trials, because he was the expert, the inventor? For one of a better word. And we paid them to come over here for a week to do some trials. Just at the moment there were trials in the launder, using our PROCESS, and then we did one trial run at the end of it using their recommended parameters and that all went very well, the results of that were very good	Resource allocation. Brought in overseas expert to facilitate.	Resource allocation
	"We wrapped up the project, fully implemented and we did a validate gate review [control phase] at some point. I think that was almost to finish this one off for my training."	Success. Fully completed and put away.	Project success
	Responding to any major conditions that led to the success: "Basically it was almost a no-brainer kind of project……. If you were to look at it from the outside, and you'd probably way it's a just-do…..but there was still a lot of things that we had to go though, because there were question marks because the more you know, we know we do products that a lot of people can't, so it will have an effect on them."	Simple straightforward project. Almost didn't need a formal DMAIC process. However useful to determine if there would be any detrimental effects to others areas on the organisation.	Project structure

Interview 2

Interview 2			
Senior Management interview	**Quotes**	**Thoughts/coding**	**Group/category**
	*Response when asked how Six Sigma/DMAIC is utilised on site: "*It's not used in every project; it's differently targeted for specific projects… DMAIC process is brilliant, it brings a discipline to project management and resolution of issues, especially ongoing issues, something we've found that we've attempted to fix 10 times sometimes."	Not used for every project. However interviewee is a strong advocate for Six Sigma's benefits. Consistent with the yearly trend of continuous benefits.	Benefits of Six Sigma
	"Define is very important, so defining what is the issue, we are really trying to understand it and then you get into your measurement and my personal experience is that's an area where a lot of times that step is missed, so there is not good measurements being taking so there is a lot of assumptions there you know, that we know we've been doing for years its always this so, you jump through to the next stage if you don't follow the process and you can't really analyse because you are only shooting from the hip and guarantee you'll make a whole lot of assumptions and that's where the project falls over..... So DMAIC that defining and setting the boundaries is really critical so you know where the scope is and don't creep and grow the project, measure is critical, absolutely important."	Importance of define. Narrow down the objectives and what you are trying to achieve (project structure) additionally importance of accurate measurements. Know what it is exactly you are measuring	Project structure define) Measurement
	"I'd say about the process is that, um, anybody that's starting out using Six Sigma and DMAIC the, for your first projects, is critical you don't scope a large project, find an important project, but one that's not over taxing on the individual ad so that they can learn to use the process, give them some quick wins if you like."	Again, really narrow down the define stage. Understand what is in scope and what is not.	Project structure (define)
	talking about a smaller project: "After 30 years [experience] , when you go out and ask people, so what's the cause, everyone's got a different view and how it might be, EMPLOYEE has done the measure phase and determined that, one, the difference between number 2 [machine] and number 4 [machine] is not great."	Team involvement. Getting buy in from those on the front line.	Acceptance

	Still referring to smaller project: [implement phase] "he wasn't there; it got implemented over a weekend when he wasn't here. He said just do these things in this order, and did it… then we had a while lot of issues and then one day we went back and checked, they didn't follow the instructions they were given, they went back to their old ways and got a whole of defect PRODUCTs, so unsuccessful outcome, but it proved also that if you don't follow the steps you're going to get a disaster. ..... Example of when you go and check the data and see rather than just going and blaming EMPLOYEE, they actually found the guys themselves didn't have the machine running correctly..... So powerful in terms of showing you, you need to have XYZ in place, and you need to follow it, and if you don't follow it guess what happens."	Communication and control phase. Everyone needs to be on the same page and follow the same protocols. This is why control phase of DMAIC is so important. No point implementing a solution only for it to revert back to previous flawed state.	Project structure (control)
	Talking about how success is defined: "It's all about meeting what you, the objectives that you set out for, if you define the project well and you really do need to spend the time up front defining it well and understanding what the success factors would be then um, that sets you up for the best chance of success."	Importance of defining the project early on. Knowing and understand the primary metrics and whether or not you have reached the projects objectives.	Project structure (define)
	"The other thing is if you define it well you can also recognise relatively quickly when you get into the project, which this has happened more than once, we've got into a project and through the measure phase, and generally start analysing the data and actually find this project isn't going to address the issue, because now that we've measured we've realised that what we defined is different to where we're at, so EMPLYOEE can give you examples where we have stopped the project, so this has to change. "	Define phase as important as is measurement. Both play important roles in understanding when the project is successful, or if unsuccessful when to call an end to the project.	Project structure (define) Measurement
	Talking about projects killed off early" But it's still been of value, its taught us something, so you know, boxing on regardless is not the way to do, and going outside of scope is not the way to do this, if you have to go outside of scope you need to stop it, re-scope the project and redefine is as the core DMAIC."	Alternative meaning of success. Killed off projects still provide value through knowledge and experience gained.	Project success

	*Talking about factors influencing success: "*The Improve and Control….. We've put in the improve phase and then 2 years, 3 years later, we are right back to the same problem because we haven't locked in the control side of it…….But if we put all the controls in place, well EMPLOYEE does in the end of the project, which is getting close, and I know about it, and the superintendents out there and knows about and the crew leaders know about it. But then I change roles, the superintendent's changes roles there is a real chance that it could fall over because you don't have those individuals looking over it and controls can't rely on individuals that need to be systemic."	Project structure. Control phase is important to ensure the situation does not revert back into its flawed state. For example team members leave, is the information/processes passed on or is it forgotten?	Project structure (control)
	Talking about percentage of time spent on a project: What you try and do it the likes of some people are full time BI Six Sigma specialists so EMPLYOEE and EMPLOYEE are at the moment. But someone like EMPLOYEE who's a green belt in his department, what we try to do is integrate his current work; give him his projects the links to his current. So it's not in addition to your current work its part of your current work. That's the secret.	Maintaining commitment. Keeping employees interested and involved with the project. Seamlessly integrating both project work and regular duties would make it seem as if it wasn't extra work.	Acceptance
	"Sometimes defining is really simple and other times defining what it can be is really difficult and setting the measures, so what are the metrics going to be? What's your critical X that we are after and what's the secondary metric that makes sure that you don't gain one thing and destroy another."	Again define is reiterated as important. Getting the project right from the start. Also mention of making sure you don't achieve something but sacrifice something else. Same as interview 1 project.	Project structure (define)

	Commenting on the leadership that senior management provides: "It's about knowing that I'm available and approachable… so it's about getting off on the right foot and make sure we are aligned so we all understand what we expect to get out of this. And that they come for support or whatever. ...if I can't do it myself, then I'll get onto one of the other subject matter experts and get them to provide support. "	Door is always open so to speak. Help and leadership experience is there if needed. Shows management commitment Extra resources are available should they be needed	Commitment Resource allocation

Interview 3

	Interview 3		
Project	**Quotes**	**Thoughts/coding**	**Group/Category**
3	"Should do green belt six sigma training with obvious idea of getting us through the qualifying, very, how should I put it to you, very challenging for a person like me mainly because of our educational background	Green belt training	Project background
	"I think we go, six sigma green belt, um, whole driver is to get these projects done relatively quickly, and you need to be able to get two projects done within the 12 month period."	Green belt training	Project background
	Talking about main driver: " probably two factors, one of it was for the improvement with regards to our health and safety of your people out there…. And also look at how we can perhaps improve our cycle time. "	Drivers for project: Health and safety Process efficiency	Project background
	Talking about project timeline: I think it was 12 months to do the data collection and then get PRODUCT build up took two years. …. I personally believe it went over by 12 months"	Project length. Could have been shorter.	Project background
	Talking about steps or phases that were the most challenging: I think the key thing to get done right is the project charter. Here's your project charter and the kept thing for someone likes of me, with my background is more about SIPOC…Ensuring that the business benefits are there, so must make sure we have business benefits for the energy and effort we're putting in, so the project charter is the critical part and SIPOC, you know what's in and what's out of scope	Project charter is part of the Define phase. Provides clear lines of what is and isn't in the scope. Also SIPOC showing use of Six Sigma tools.	Project structure (define)
	"So then doing the measurement phase how did you know that your measurements were accurate": We had three operators involved in the measurement. But using those guys each time for driving the design. So we collected baseline data with them and also then did the final trial with the new design in there.	Maintain validity and accuracy of the data. Different people work in different ways. Using the same three guys should give more consistent readings.	Measurement

	"*So what went well with the project or what maybe didn't go well?":* What went well was the buy in from the guys actually. From the team after we did out Fishbone actually….. I approached the crew leader to select people in their crew that would, um, like to participate in it. Obviously you want people that want to do stuff, not people that have to do it. But you also want to chuck someone in there, generally I look at people I want to put in there.... you want people there that are going to challenge you and put it out there.	Incorporating members from the group that would be most affected by the changes. Leads to large amount of 'buy in' and acceptance. Want to have members that actually want to contribute, not just feel they have to be there because it's part of their job.	Acceptance
	Responding to when asked about any extra resources allocated to project: "Resource wise the guys that actually participated in the fishbone and some of the project were utilising because they had an interest in it. …. You know that communication plan etc. is probably a key thing that maybe we could be a wee bit better.... having the team do the fishbone diagram, coming out with the information... the four crews outside the team that did the fishbone.	Extra resources in the form of information. Approached people not directly working on the project to get their opinion. Once again reiterates the theory of acceptance.	Resource allocation Acceptance
	"Would you say there were any other factors that would relate to the success?": Yeah probably, well time wise it was, just you know having two things. Time wise it's learning to understand the external influence it could have and also the other work you have to do throughout the day has another impact of the project.	Shows importance of define phase. Clearly understand the factors and circumstances surrounding the project.	Project structure (define)
	"Did you have a black belt sponsor?": EMPLOYEE was yes, EMPLOYEE. He's a black belt……EMPLOYEE is very good at teaching, so he's very good at when you ask questions explaining to you and teaching the right methods to you.	Assistance there if required. Black belt with more experience available to teach and train.	Resource allocation

	The big thing about the whole team work thing is that we used, you need to utilise your front line leaders and your crew leaders. They are the people that are managing and implementing the change. Although I've made the change, put the systems and tooling in place, the guys are the ones that do the work	Making the most of the resources available. The workers will have more of a connection to the project Once project is completed, the controls need to be in place to continue how the project was left. Importance of control phase	Acceptance
	Talking about communication throughout the project: It's more like the management of it. So it's the front line leader, how he managed it after I'd done the work. So they wither took that as a priority and/or they had something else that was more urgent to them.	Once project is completed, the controls need to be in place to continue how the project was left. Importance of control phase	Project structure (Control)
	"Well the key thing for us is the safety of our people, plant and processes."	Driving factor of the project. Health and safety one of the core value of the organisation.	Driver: health and safety
	"One of the key things we had at the start was some of the guys, when we first brought the PRODUCT in, did they believe that they we no good. So they were having issues and adjustments, so it was probably 2-3 guys that were pretty adamant that the design was no good, whereas when you look at the work they were achieving the results, so a huge reduction in spillage, so I'll tell you about the guys those guys today you hear nothing from them, they reckon the PRODUCT and PRODUCT are absolutely perfect.... so you got to get out there and influence and spend the time with them, so I spent time with three of the guys to get an understanding of what their issues were and in fact what we did find, is the problem had nothing to do with the PRODUCT at all.	Importance of getting all those involved on board and accepting of the project. Also shows effect that integrating the project leader with front line worker has and seeing it from a differing perspective.	Acceptance Resource allocation

	"So there is definitely an upside with Six Sigma?": Oh hell yeah, all the years, Like I say Lean Six Sigma. Definitely huge improvement and even learning for a person such as myself that's been in operations for 34 years. You're continuingly learning ways to approach stuff.	Positive benefits of Six Sigma. Facilitates continuous learning and upskilling.	Benefit of Six Sigma
	"You've got to get it right from the start. You know, for a person likes as myself, to me, that's one of the key things, and I've probably noticed that with when you're looking at scope of work right, what's in scope is if you've got SIPOC right…. identifying everything you want in it.	Importance of knowing exactly what you want out of the project and who it will effect. SIPOC just one of the tools that Six Sigma uses to achieve this	Project structure (define)

Interview 4

Interview 4			
Project Number	**Quotes**	**Thoughts/coded**	**Group/category**
4	"I think it's been an ongoing issue… how can we improve this process to make it more capable and in control… Oh I guess cost involved as well as we have to use a shed. It's also raw material that we use for our PRODUCT."	Drivers for project: Cost reduction (financial) Process efficiency	Project drivers
	"Yeah I guess it was within 12 month approx….. So I just started working here and I got trained in Six Sigma when I first started and it was one of the first projects that I was given to complete	Green belt training.	Project Background
	"*Did it meet all of the objectives that were set at the start?":* Yep so I passed all the gate reviews and completed both the projects. So in terms of that, that would be a success in saying that there was an outcome and it was improving the situation. We had an out of control process. Lots of variation and then we came into a process where we could actually measure what was coming in, what was going out, within specification.	According to all the definitions of success and the organisations own definition of success. Technically the project was a success. It completed what it set out to do and brought value to the organisation.	Project was successful
	"Yeah so this project had three different departments that used this process. So you've got to make sure that the guys in shipping were on board, the guys on Roding were on board and the guys in green were on board. So you had three different departments all with different crews as well. So you've got to, in one case there were two departments that were on boards and on department that took a while to get on board. So that was difficult I guess, you just persevere. Just work through it all. Identify what's missing and then give more attention to that area.	Multi- department project. Lots of moving pieces and people. Importance of communication and organisation.	Project Background

	" *What would you say were the big contributing factors that lead to the success of the project?":* definitely with [PROJECT 4] the success was the communication because in the end it wasn't just one department it was three departments with four different crews all working together in one sort of process, so that was a success. Because if you don't have the acceptance of your crews then nothing's going to work, it might be a great idea , but if they're not on board they're not going to do it	High levels of communication were important due to the sheer number of people involved and the fact it was a multi-department project Gaining the acceptance of those that the project will directly affect. Can have a great idea but if you can't implement it then it's useless.	Acceptance
	"Yeah, of course it's got to be a good solution and you've got to get input from the guys, you can't just make it up and say 'hey guys'. They've got to have input and have acceptance of it and understand but it's got to be communicated as well. …. And if they weren't happy then they weren't going to do it. and then you see nothing would happen	Importance of getting input of those that the project will directly affect. This input will lead to acceptance of the project outcome/solution	Acceptance
5	"*So what was the main driver for this project?":* Yeah so it was cost and health and safety. So you know the cost of making PRODUCT…… so if it cracks it's a lot of manhandling and reprocessing as well… and then they are blown to pieces so it's health and safety as well	Main drivers for this project: Cost reduction (financial) Health and safety	Project drivers: Cost reduction Health and safety.
	"So basically we have a measure of transverse strength of the PRODUCT and from time to time, you know, it falls out of specification, so you want to sort of identify what causes this… and because it's one of our KPI metrics and we monitor and report on it. So it's important we report on it every week and monitor it.	Simple background regarding the project.	Project details
	"So the people involved were the DEPARTMENT and DEPARTMENT because they were the ones measuring it.	Multi department project. Communication levels will be important when liaising between depts.	Project Background

	“So *you went through the analysis and was that a difficult stage? How did you go about getting those results?”:* so you’ve got two different areas of the plant where you’re going ok, what are the different conditions of that one…. Ok there's nothing really standing out, nothing significant, so get the team together..... So you know you need to get your experienced team, your experienced engineers saying 'yep we think that too' to get a voting system and go forward with that.... It was just more like there was nothing 'yep it's definitely this'. It was more like, 'this has some sort of relationship"	Utilising the resources at their disposal. Talking to those that have experience and gain their thoughts on the situation.	Resource Allocation
	"The project was classed as a success?": "It's been passed control gate, so I'M still to hear if it’s been through validate. So after a couple of months down the track there will be a validate gate review.	Part of the control phase. Or more like an extended control phase to check that the project has been implemented effectively and is still operating as planned	Part of the control phase. Ensuring that the project maintains to results even after an extended period of time.
	"So this was basically around how it was measured, as there are a lot of different factors when you get the actual core out of the PRODUCT and that it to the labs. So just mapping out exactly step by step what’s going on and doing analyses about different factors, variation and repeatability.... yep so I made like a detailed plan with you know, time/steps of when it was going to happen and when we were going to start and everything had to be. The process had to be stable.	Project was very organised at written up as a step by step process. All this would have had to be planned and thought out well in advance during the Define phase at it would directly affect the measure phase	Project structure: Importance of Define phase.
	"Yep so in terms of being successful we got a result which was what we wanted and we were able to make some conclusions from that. Because sometimes you run an experiment and the results, there's no relationship, you can’t find anything so I think in terms of it being successful we were able to make conclusions from the trial	Project provided a positive benefit and value to the organisation. Therefore it was deemed a success	Project successful.

	*"What other factors would you say contributed to the success of it [the project]": "*I think having the acceptance of the superintendent at the team…. So just having the resources, the availability and acceptance of the project. You know it did take a while to talk about that we were doing but once you do that I think you can do anything.... I think you can do anything, but nothing's going to work unless you've got the acceptance of the guys.	Once again mention of acceptance being an important factor. Or else the project can't be implemented effectively. Also making the most of the resources at the projects disposal	Acceptance Resource allocation

Interview 5

Interview 5			
Project Number	**Quotes**	**Thoughts/coding**	**Group/Category**
6	"So this particular project was based in DEPARTMENT, it was a project that was, I guess. The driver was an acute problem relating to musculoskeletal illness and the number of forms they take. So really those that was involved was really a big area, we had the three lines. There's three output teams amongst those, there was TEAM and TEAM, so that's another two teams and there was reconstruction."	Large project with lots of different groups and people involved. Project driver: health and safety	Project driver: Health and safety
	"I was black belt at the time…. I think from memory it went for about six months, maybe a bit longer"	Simple background information: Fully black belt trained, project timeline extended for approximately six months.	Project details
	"Ok so the scope was really around identifying the process that caused the hazard. Where the exposure was and to map a pathway to address those…Anything involving shoulder movements."	Project background. Health and safety project to try and identify causes of a specific injury (shoulder). Different to a standard Six Sigma project.	Health and safety. Different to a standard Six Sigma project
	"I think every project will have at least one stage that will be hard. There's issues and barriers guaranteed. This project itself the definition was reasonably difficult…. With the goals being narrowed, taking the scope from that was very helpful. But a lot of the Six Sigma tools, like the process map, what does the process look like, what does the measurement look like, what would the secondary metric be."	Six Sigma is more suited to manufacturing. However does provide a series of tools that can be put to use in a project such as this one. Definition was reasonably difficult to narrow down as how you find a primary metric for a project such	Project structure: Define was difficult Six Sigma provided tools that help to overcome any issues.

		as this. Six Sigma tools must have helped to narrow this down	
	"Did you use those outside resources in the project?": Certainly you know, I consulted with the medical centre, and they forwarded some of those resources onto me…. You can go to OHS [occupational Health and Safety] and type in musculoskeletal injury' and it will show you heaps, well there is a model with a load of different factors, that vary from physical to the psychological and environment. There's individual factors, there's lots of stuff.	Utilised outside resources and also put to good use the experience and knowledge from those on site. In this case it was the medical team that deals with the injuries. They would have had the most knowledge and also theories/medical knowledge on the best way to remedy the situation.	Resource allocation
	"In your opinion what do you think led to the success? Were there any other factors that helped?": I think at the time, I went and talked to each and every team so that was a significant investment. Listed a bunch of stuff from the team themselves. So that provided a fair input. But I don't think is wasn't from all teams. It was more like the leaders and team reps. ... we also created a survey which went out to all, so the opportunity was there for each member.	Employee knowledge was utilised. Get everyone's thoughts on the matter and hopefully that may uncover some conditions that were not previously thought of.	knowledge and experience
	Talking about interviewing employees for their thoughts on the project: Well I wanted it to be face to face, so to a certain extent there is going to be a certain amount of time to get it around…. Ohhh communications very important and a lot of effort was put into that during the project... uh it was open and informal would be an apt description of that.	Face to face communication provides a 'richness' of information that one would not get from email or typed answers. Stems from Media richness theory.	Communication

Interview 6

Interview 6			
Senior Management interview	**Quotes**	**Thoughts/coding**	**Group/Category**
	"[ORGANISATION] thought it would be a good idea thing to try (Six Sigma) so they set up quite a large internal structure to get the Six Sigma program up and running which included people in the specific roles looking at management project portfolios, training, governance roles and they tried to train up a series of green belts at that stage..... But there were very few of them, only one or two around site.....Through that time we kept training green belts and black belts. Most of the training was done overseas at other sites, so we flew people to be trained in Australia or something like that.....We had quite a large restructuring event, removed most of the lean people from the business, but those that had Six Sigma skill set were then trained up in the lean and became lean six sigma belts. That's sort of the history around how we got to where we are today."	Background information on how Case Study Organisation trained and implemented Six Sigma in the early stages.	Case Study Organisation background Information
	"We've won many awards around Lean Six Sigma and the business and we've had many people come visit for 5S and QCO's and things like that.	Recognised as implementing Six Sigma to a high standard.	Benefit of Six Sigma
	"So the issue we have is when a new person comes in they appear to be going into a foreign environment because of all the training everyone's had so the common language between the operation people is QCO's and KPI's which are quite foreign to new people coming into the business. So that gap has been widening over the past couple of years....There will be an element of osmosis happening out in the field but the best thing to do would be to provide all the operators with that core skill set, so that's definitely a gap that we hold to be addressing in the future..... But the good news is that most of our leaders on site have had Six Sigma training. So all the senior leaders are pretty much Six Sigma certified. So every member in the business is either green belt or black belt.	Training new people that come in the organisation. Some time it takes time for them to become accustomed to the slang/language used on site. But eventually nearly everyone on site becomes green belt or black belt certified.	Training.

	"We've come from a really good foundation and its always been supported and nurtured from senior management and that in part is due to the fact we've had really well selected projects and we've depicted significant value over the years….. I think we are quite lucky here because we are fairly autonomous. Which means we can effectively train our own green and black belts on site, with no external parties.... Yep so we've got the champions and I'm also the only Master Black Belt in the southern hemisphere for ORGANISATION.	Commitment from senior management has always been strong. High level of efficiency when it comes to training due to having a Master Black belt on site	Senior management commitment. Training
	Responding to whether Six Sigma has provided value to the organisation: Yes, I guess the complexity in a lot of projects, that when you do a lean project, you can't necessarily link it to the value, but one of the key mandates of a Six Sigma project is how do you link it to a KPI in the plant so that you can see that value flow to the bottom line. So a lot of the projects go through a validate gate, where you actually check that we've made all the improvements to the KPI or we've said we have and we're seeing the value in the plan.	All Six Sigma projects must have planned benefit to the organisation. Otherwise it would simply be a waste of resources and effort to continue the project. Validate gate is a form of an extend control phase. Ensuring that the project set out to achieve what it planned and is continuing to operate as expected.	Provide value to the organisation Project structure (Control)
	"With a purely business improvement hat on my head, the only reason this business has stayed in business is because of the business improvement program, so we tend to offset all the increases each year by the project work that's done…. We tend to keep ahead of the cost increases and everything else, and the profits the business makes are usually quite proportional to the business improvement value that year.	This combined with the graph showing business growth since Six Sigma implementation provides another recommendation and belief that Six Sigma provides positive benefit to the organisation.	Business benefits.
	"So our site out of all in our peer group, we would have the lowest controllable cost per tonne of PRODUCT produced of all the businesses. And that's through the rigor we're applied through our training workshops and how we got about business. So business improvement is across the whole site, it's not just a core group of people, it's about the culture across the whole site.	Whether it's due to Six Sigma or not, something is working at the Case Study Organisation. Interviewee may be biased but	Business benefits of Six Sigma.

		believes that Six Sigma provides a monumental benefit to the organisation	
	"So it's about everyone feeling they have ownership over what happens?": Yep it's about everyone feeling they have ownership. Feel like they can contribute and everyone feels like they are being listened to and they can see and trace their idea through the process. 'So not all ideas are good ideas, but every idea can lead to a better idea'	Once again mention of ownership and acceptance. Incorporating everyone's ideas or at least make them feel they are benefiting the project is an important must be highly sort after attention to detail at the Case Study Organisation	Acceptance
	"It's called DMAIC for a reason and every phase is absolutely essential to have confidence to go on to the next phase without having a whole lot of rework. Unfortunately without that rigor a lot of people jump to a solution and may solve a problem that's not really a problem because they don't understand it. SO I guess the key success criteria I think is systematically going through the DMAIC process and having gate reviews were everyone is lined up and go through what's been achieved throughout that phase.	Project structure becomes essential to ensure that the project won't fail. Interesting thought as to people often skip right to a solution before working through the necessary steps. Additionally gate reviews are part of an extended control phase.	Project structure
	"I guess the other success criteria is that process enables people to come up with solutions that they may not have come up with before. So effectively its taking away some constraints to the whole construct behind DMAIC, is you diverge and come up with some quite divergent thinking... so you go wide and capture everything and then you come in and capture that thinking. Which is that captured convergence. So that's tied into the DMAIC process.	DMAIC in itself provides a process for success. Using a step by step process narrows down the chances to mess up. An added bonus is that they way that DMAIC is	Project structure

		structured is that it collects a lot of data/theories/information before narrowing it down to the specific CTQ's and attributes	
	"I guess the other thing that's key to a projects success would be tenacity. So a lot of people when they hit a stumbling block they tend to give up. The Black Belts we have a tenacious. They will take a problem through to solution. They will keep hunting and looking for a solution for a pathway and we try and coach out green belts to do that's as well."	Does tenacity stem from the training Black Belts receive or is it simply a personal characteristic? Training can provide the thinking and show ways around problems, but some people might be more adept at it that than others. Therefore choosing the right candidates for Black belt training is important	Training.
	"So there is a lot of frustration that goes with doing a project unfortunately, so that's why you've got to have very good sponsors. They are able to remove those barriers. So there is quite a few barriers in the project suite that can't be removed but the candidates themselves... [Green Belts] they have a direct relationship with the sponsor or leader of that project... So I guess the sponsorship is quite key to supporting that process.	Senior management commitment is important to providing help and resources when required.	Commitment
	The Six Sigma program is encouraging, there is no point in having a great idea if out can't do anything with it. So it's all about getting acceptance…where the trick is to actually get acceptance which is the ownership of all the people involved in the area. So they actually take that idea on board, that solution and accept it and support it rather than someone jut writing a report and handing it to someone.	Getting acceptance of the employees mentioned. Almost identicall thinking; sure a great solution but if you can't implement it if Its useless to the business' and just results in a waste of effort and resources.	Acceptance

	"Because you've got total acceptance, everyone thinks it's their work. I've had lots of projects where I've walked away and no one's actually known I've done the work. That's because it's had total acceptance from everyone involved…. They just carried it on, it's just the way they work. So it may not be the best solution you've got, But if you can get a solution across to the people that are running it every days it's got a better percentage than one perfectly documented solution. So the best ones are the ones people just carry on doing.	Once a project has total acceptance, it moves from being someone else's project to 'our project/solution.' People will be more heavily involved with a project they believe they had a high level of input in than one that someone else came up with.	Acceptance
	"Because that's the leverage pin for Lean Six Sigma. It's about the ability to demonstrate that we can make a change and get the outcome we want…. When you can turn something on and off you can truly understand the factor and the order of magnitude of impact it has on the outcome. When you know that you can lock that in and get some control factors around that. ... That's the ultimate, the end of a Six Sigma project. That is the phase of divergence, so that divergent phase is to determine what all the inputs are and the convergence phase is trying to eradicate some inputs and come down to the core set, and demonstrate that it is indeed the set that will give you the KPI that you want. So that's in the improve phase. That's probably quite essential. But you can get that done unless you've done all the previous phases. So you have to know how to measure it, you've got to know the uncertainty in the measurement.	Six Sigma is about controlling what data you're going to get, knowing what inputs cause what outputs. Also showcases the Importance of working through all the phases of DMAIC in order to ensure success. Divergent phase is to understand that the inputs are and convergence is choosing which ones directly contribute to the KPI's that the project requires.	Project structure

	"So *during that measure phase how important is the accuracy of those measurements?":* It's absolutely essential that you understand what the percentage of variation in you measured outcome is coming from your measurement phase... Often people think it's good enough, but they find they can get the difference in the outcome so they have to go right back to the measure phase.	It is important that those working on a project have with certainty the figures they are receiving from the measurement phase are accurate and true, or else the rest of the project is put at jeopardy of failing as the measurements might be completely off or out of scope.	Measurement
	"It's like being dropped into a forest in the middle of the night with trees all around out and no compass. So the whole purpose of DMAIC is about to try and create a little bit of a clearing, to create a bit of hope basically, so at the define stage you should be feeling absolutely overwhelmed that you have no possible way of solving this problem. That's why we have the processes. At the define stage you've only got limited knowledge to actually complete the charter. As you go through the project and phases you actually gain more knowledge, so actually the way it works is that the further you advance the more you gain. A lot of people try and tie a solution in at the define phase because they are nervous about where they are going, they have to have a solution that they are moving to. That's not the way you solve a problem because that locks all of the thinking out.... It's layering it up which is why the gate reviews are quite critical. A lot of newly trained green and black belts struggle with all of those constructs as they are not used to working in a thick forest with no navigation.	DMAIC is a systematic process for a reason and all steps must be completed in order for a project to have the highest rate of success. Very good analogy about being in a dense forest and needing to make a clearing. A project should be confusing at the beginning, or else there wouldn't be a need for a Six Sigma project.	Project structure

	Continuing from the forest metaphor: That's where the coaching program is essential as well. A lot of the Black belts we have are seasoned veterans. They are used to that, they know how to get people out of that. Quite often if you're in a thick forest at night with no way to see out. One of the tools you might give someone is an axe. Start chopping trees down and make a bit of a clearing. That's how I see the Six Sigma tool set. It's all about providing those tools and guidance to get those people out of the forest. Because once they are out of the forest they can actually solve that problem.	Shows link to leadership experience and the commitment that the Black Belts have towards the Green belt projects. Additionally outlines how some of the Six Sigma tools can be applied to assist with a difficult project.	Training Experience
	"So that acceptance gets built right up from the define phase to the control phase. So it you have a lot of acceptance in the control phase the acceptance becomes easier. So we encourage and involve people from the start, the whole way though so that you ado have that acceptance and make that control phase easier. If I had to pick a phase I'd day the hardest one is the control phase. .. To stop regression so to confirm how that goes we will normally have a validate gate review after a control gate review. Just to have a look at is everything locked in.	Producing a high level of acceptance in the control phase (where it is most vital) stems from the work put in during all the other phases. Involve people as soon as possible to build trust and acceptance.	Acceptance Project structure (control phase the most difficult)
	So the most important equation we use in Six Sigma training is R=Q*A. Results, quality of work and acceptance. So that is the most important equation we have in Six Sigma. We pound that from day one, because you are right, it is much easier to change an accepting person than someone that is resisting.	R=Q*A. Most important equation within Six Sigma at the Case Study Organisation. Results come not only from the quality of work but also the acceptance of the work	Acceptance: R=Q*A

	"So I was wondering if you could comment on the leadership and support roles that the Black Belts play during a Green Belt project?": So I guess we are quite lucky on site because we are fairly autonomous. We have quite a number of certified Black Belts. We can actually do the training ourselves. I do get some of the Black Belts training Green Belts themselves. Actually build up a Rapport. Also the other thing that's important with that is we ensure the Green Belts have a project going into the training, so the Green Belt can progress the project through the training. In my view the training on its own is useless. It's only when the people get out to the field and apply the tools and framework does the learnings get locked in.... We try and make that as a pull system, the Green Belt is encouraged to ask Black Belt for assistance. .... So the formal program that I have is I expect the Black belt to be coaching all the Green belts and I expect them to make time available at the drop of a hat. So if their working on a one million dollar project and a Green belt asked them for assistance I expect them to drop what they are doing and help the Green belt.	Black belts have a say when training Green belts. Committed to seeing them succeed. Pull not push system of asking for assistance.	Training Experience Commitment
	"So we have a couple of tools that we recommend. So that's the use of a parking lot. So a parking lot is people will normally get an idea and want to spend a lot of time on it, but it might be irrelevant to what work you're doing. So it gets put in a parking lot to hold it somewhere so it doesn't derail the discussion that's happening.... they are involved but their involvement is often to tear ideas down. So it's about balance, they're in a workshop, their getting acceptance which is great , but it's about what are we going to be doing differently in the future. So often it takes a lot of facilitation skill to move an entire group... any meeting without action is a waste of time.	Gaining acceptance is amazing during a project but it has to be constructive acceptance. Not speaking up for the sake of talking, or tearing down other ideas in favour of your own. The Parking lot is one tool that creates balance. Saves the idea for later so the employee still feels valued and will continue to contribute	Acceptance Experience

Interview 7

Interview 7			
Senior Management Project	**Quotes**	**Thoughts/coding**	**Group/category**
7	PROJECT was because there was a number of items with the DEPARTMENT, or potential items identified with the DEPARTMENT. The understanding of them all together and how they potentially made up a cluster of projects wasn't well understood. So this was a project to pull all that information together and understand that better. To get an understanding of the benefit and effort required. To get an idea of the overall value of going ahead with some sort or PROJECT.	Project Background. Not a typical Six Sigma project. This project was grouping a series of projects together to gain a better understand of the benefit and effort involved, to see which ones needed priority	Project Background.
	"Because this was an enabler there was no financial benefit…. I had a prioritised projects that was what my key metric was. 'Key number of Prioritised projects to progress the critical few.' so that was my initial metric. What we found was that even though we prioritised them they still didn't hit the key few, because they didn't hit the minimum, the benefit/effort was still too low.	So not financially driven. Would be classed as Process efficiency as it was sorting through a series of possible project to see which ones would provide the most value for the smallest effort	Project driver: Process efficiency.
	"Which is why we came up with the PROJECT kiazen idea. So that brought them all together and made them worth have a million. The effort for the Kaizen project became a week's work for about 15 people in a Kaizen and then you can go right, still benefit verses effort probably not idea, but its stuff that needs done so we will do it anyway. .... It was then we created a list of new projects which became the PROJECT Kaizen which then became a critical few.	Because Benefit verses effort was so low all the projects were brought into one big Kaizen. However this became a separate project, as the project had no reached out of scope.	Project Background.

	"So during this you were a black belt?": Yes…. *"Does that mean you were effectively 100% of your time dedicated to this?":* Yes 100% time.	Details about the project lead. Black belt at the time meaning 100% of work time was spend on this project. It should also be mentioned that this employee is a member of the Business improvement department.	Project Background.
	"At the time I'm also in what we call BI partnership… So the BI team, were are all allocated a department which we look at… so if someone out in the, well anyone that's part of the assets team if they want BI support they can come to me, that can be something like how do I graph that, how would I find something out, or how do I run a t-test.... right through to the managers will often say ' hey I want some support for this project'.	BI partnership. What interviewee during interview six was referring to when mentioning each Black belt is assigned to green belts and is expected to assist them whenever it is required. However instead of between sponsors and coaches it is between a Black Belt and a single department.	Commitment Training
	"And then so even the projects that you didn't get completed…?": There's pathways for now. Some of them you just couldn't get completed. But now we've got system, part of the Kaizen was they put a system in place in the maintenance system where they are doing that routinely now and so over time we will get through that. But it's not something that I can say we've saved this much money on compressed air over that week.	Not all projects were completed, that wasn't the objective of the project. Objective was investigating which had the highest benefit/effort ratio. Uncompleted projects have the foundations set for project continuation	Project success

	"Ok so to what extent was this project a success. Did you meet the goals you set at the start?": Well I mean we identified 1 million plus dollars. In terms of this one there was not savings identified, it was just an enabler. So I guess in terms did it meet what it set out to meet. Well yes because we then went out and did the Kaizen and we've had a saving from that kaizen. If we didn't do this first then we wouldn't have been in a position to go out and do that.	Project classed as a success because it meet the objectives set out at the beginning of the project life cycle	Project successful.
	"You learn something new every time you run one of these or a new project because there is always learnings and improvements that you can make when using the DMAIC tools/gates…. It was a very people based project in terms it was bringing people together... it wasn't really a purely data driven approach. It was more around pulling together people's ideas to get what are the best projects to be working on. "	Not a typical Six Sigma project. Less data driven than others. But still the DMAIC and Six Sigma tools were beneficial.	Project Background.
	"Getting people together and I find it's my favourite part of DMAIC, is running a project with lots of people .And that's what it should do. You need R=Q*A. Results = Quality and acceptance. *"Yeah because there is no point having a solution and not accepted and followed".* Yes that's right. so that's the challenge that you have when you're running something like this... that they accept it and be able to move forward and support the project... So getting their acceptance early on is what you're really working towards during your measure and analyse phase, getting them on board. Improve and control as well. As long as your communication with them the whole way though, as long as you're communicating with teams like this it's all around using the right tools to get the acceptance.	Once again the equation R=Q*A is quoted. The process of gaining acceptance begins in the Measure and Analyse phase, however the effort must be maintained during the Improve and Control phase as well. It must be a process that continues through the entire life cycle of the project.	Acceptance
	That's what the sponsor is there for. Any additional resources, roadblocks, that's what your sponsor is there for, to get rid of. Generally they do that well, in my experience across numerous projects	Sponsor must be committed to assisting when required	Commitment
	so keeping that in mind, are they any other factors that you think contribute to a project success?": Well green belts that have a project sponsor that is engaged in DMAIC is more likely to succeed. So when I say engaged there are some managers and super	Pull system means that the green belts are expected to ask for help should they require it. Unfortunately it became	Training Commitment.

		a push system as the Black belts were under pressure to ensure Green belts succeed. Now however it is back to a push system.	
	"So I'm assuming you would rather that they come to you early rather than struggle in silence in a way?": Yes definitely. That's what we are there for, to support them and the expectation is there that they come to us before it's too late. So the site gate reviews are all the managers are invited, all the sponsors and all the belts (green and black) are invited. So we have those every six weeks and last year we were struggling to get people along. Three months we had the management agreement to make it compulsory... Well it means they are doing something on it rather than nothing at all. They have got some pressure to get it done before they have to present.	It is unfortunate that the Case Study Organisation had to make the gate reviews compulsory, the projects may have gone from something they enjoyed doing, to a feeling like extra work, extra responsibilities and pressure. I actually fortunate enough to sit in on one of these Gate reviews	Commitment
	So keeping that in mind, are they any other factors that you think contribute to a project success?": Well green belts that have a project sponsor that is engaged in DMAIC is more likely to succeed. So when I say engaged there are some managers and superintendents that have been part of the business improvement team or green belt, black belt trained themselves and passionate about it. There greens tend to succeed and tend to do a lot more projects that other Green belts... but definitely you get a better results when you have a leader or sponsor who is aligned with DMAIC	Experience of sponsor/coach plays a large role. Having the assistance there if required is a huge boost to confidence. Additionally the commitment of the Black Belts to ensure the Green belts complete projects and gain certification	Commitment

	"Is there any sort of steps through a DMAIC process that is challenging for teams?": Projects need to be the right size and needs to be achievable through coaching…. The key thing is to always keep the scope really tight and the right project size… Total sponsor commitment and the sponsor was there at every meeting including the Kiazen that went on with that project...a coach for advice for all means, we are always encouraging them something outside of scope never makes it into scope. It's a whole new project."	Importance of the project being the right size, need to be achievable. This is all worked out during the define phase when the scope and project charter is being drafted up	Project structure (define)

Interview 8

Interview 8			
Project	**Quotes**	**Thoughts/coding**	**Group/Category**
8	"So this was one of my training projects… Basically we had this problem with PRODUCT and we used this as a training project so it was something that I was going to sort out in my work anyway so it was a good one to put through the process."	Project background: Green belt training project.	Project background
	"It wasn't a multi department?": No, so we had an operator and tradesmen and a crew leader	Not a multi department project. Communication and scheduling would have been simple and straightforward	Project background
	"So every time it got blocked, we would lose on average per shipment 3.375 hours waiting for these filters to clear so that we could begin unloading again, and that was equating too nearly, just over $14,000 per year… Could be more depending on what is sitting out waiting.... *" So one of the big sort of driving factors was cost reduction for this project?":* Yeah and operator frustration, really frustrating for the guys when they are unloading the ship... and then they have to sit there for 20 minutes to wait for it to clear itself before they can start again."	Project Driver: Financial and Process efficiency. Process efficiency because the workers' jobs became more and more streamlined and efficient at the conclusion of the project. Financially driven as the Business was losing man-hours sitting around for 20 minutes waiting for the problem to correct itself.	Project driver: Financial Process efficiency
	"So obviously you are familiar with the DMAIC process... Then we went into our measure gate review. "	DMAIC process used throughout the project	Project background

	Getting that team of guys together, their knowledge and we were able to jump basically, jump a lot of analyse (phase). We still did some analyse but by putting those quick wins straight in, and then seeing what happened it was like 'aha' straight away we've got it you know.... We used them, we had an operator there and then we had maintainers that maintain the piece of equipment and they had recently been inside... done the inspection. "	Incorporating front line workers early on builds acceptance and also shows evidence of making the most of the resources that are at the projects disposal. These resources being the front line workers, as they were frustrated with the issue, had a high level of input and participation.	Acceptance Resource allocation
	"Our primary metric was hours lost" *"yeah so would you say, to what extent was the project a success":* Very successful, yep, because we met all those metrics. …Yeah it was probably a success for me in the fact that we got there so fast and we didn't really know what we were going to do, ha-ha, when we got the project I was like 'oooh really?'	Primary metric for this project was hours lost. Because the project achieved/surpassed the objectives set during the define stage, it was classed as a successful project	Project successful.
	"it's very important to define your problem at the start yep…It's easy for me to dive in afterwards and dig up all the data, but if you're not doing that and sort of relying on the operators feel and what's going on here you know, they started to work it out, it was just one product it was happening on."	Simple project, Define stage was extremely important to understand exactly what the issue was and ways of knowing the problem had been solved. This project got lucky due to the simplicity of the problem. A more complex project might have failed by relying on operators theories and gut instincts	Project structure (define)

	"Yeah we had coaches we could to to…. Yeah we didn't like, with EMPLOYEE and a lot of other business improvement people we have on site, um certainly had plenty of people to go and talk to so that was good…. Yeah if I was to set into a big project now I would be like 'hmmm ok, I will actually go and talk to the business improvement guys' and go 'what do you think we should be using here and what do you know', instead of trying to bash my way through it, there are people there to help you know.	Assistance was available if required. Those with more experience and knowledge (Black Belts) were always on hand to assist.	Commitment of senior management
	"What went well with the project": Yeah so from the team launch, we really started talking about what was going on and started to gleam some knowledge from other people, from tradespeople and thing and that was sort of an aha moment, a lightbulb moment you know... So the team launch was quite valuable in this case. "	Drawing on the experience of others By asking for others opinions on the issue the project also increases the level of acceptance as people feel more involved as they feel like they have invested interest in the project's success.	Acceptance Experience
	"Would you say there was any phase that was more challenging than the rest, you mentioned that the measure phase was quite straightforward because you had all the data?": Yeah that was good, um, and this yeah. I found this one pretty good really, the Define is so important and it's not just this project I say this for but any project. It's so crucial to get the define part nailed because that, and having the project charter really tight because it is very easy to start wandering you know, and sometimes the projects can get a lot bigger than what they start out to be."	Define was so important, not just for this project but for every project. Drafting and understanding the project charter is crucial before the project starts to veer off course.	Project structure (define)
	" So quickly you know, the guys in that team launch, um, we sat down and talked about it and were like 'well these blowers (the hoses) are worn though so the air slides aren't running properly and it's the material and it's blowing dust everywhere…We had a lot of buy in from the, um, operators. They were really good and really supportive you know because it was obviously... they were quite excited that someone was actually showing a bit of interest and trying to do something"	Buy in levels were high. Workers were getting frustrated with the lack of solution, they were happy to provide assistance in making sure the project was a success. Leads to the high acceptance rate.	Acceptance

9	"It was quite interesting because they had a special tool made up for measuring their PRODUCT. So we did a gauge repeatability and reproducibility study. So we had all the different operators, and did the proper study and ran it and it turned out that their measurement study didn't work.	Project background. Project discovered that the measurement system that was being used was inaccurate and was not providing readings that the project team could rely on.	Project background Measurement
	"So at what stage of the project was that discovered? In the measurement phase?": That was during the measure phase…. It was in the measure phase before we go to the analysis. So then I built a new measurement system and we got it a lot better."	It was during the measurement phase that the faulty measurement system was uncovered.	Measurement
	"So that project ended at that point and set up a new project?": Well I don't know, it's never happened. But that's what we did, we called it quits there…. So that's where that project ended and we made a recommendation of what we needed to do if we wanted to be able to move forward.	Discovery of faulty measurement system mean the project had drifted out of scope, so it was decided to kill the project and leave the remnants as the foundation for a new project.	
	"We had a lot of buy in from the guys because it's another frustrating task for them so they were right on board trying to help me.	Again we see evidence of building acceptance. The workers were invested in the project because it was making their jobs more difficult.	Acceptance
	"Okay so what were the originally objectives or the metrics for that?": Yeah, rejecting cell rate.	Primary metric. Reducing rejected products produced	Project background

	“So technically that [Primary metric] wasn't achieved in this project?": Nope, well it depends how you look at it I suppose. We finished it because there was nothing else we could do. We had found root cause, we knew what was causing it. We couldn’t get there because the machine wasn't capable.	Project was killed off early as it could not progress under the guidelines and scope that was set during the define stage. Still classed as a success in the eyes of the Case Study Organisation, as it provided value to the organisation.	Project background
	"Yep, so my Black belt coach and sponsor made the decision. It started to get out of scope, out of scope was replacement of PRODUCT, and that was one of the big things that was wrong… right from the start we had that as out of scope. "	This was a green belt training project as the project leader had both black belt coach and sponsor on hand to assist Shows the importance of the define phase, clearly outlined what was in and what was out of scope.	Green Belt training project Project structure (define)

Interview 9

Interview 9			
Senior management	**Quotes**	**Thoughts/coding**	**Group/Category**
	"I guess project election can occur in a variety of different ways, in that we have processes that try and identify the most attractive project based in the amount of effort versus the benefit we get out of it… because you know a $5 Million project that takes us five years to deliver is less attractive than a $100,000 project that we can get in the next two weeks."	Project selection is an important factor when looking at implementing changes within an organisation.	Project selection
	"So if we are going to go with the Six Sigma route then things really do start to fall quite heavily on the sponsor and leader on how well they keep them to that, get the gate reviews at the right time….I think quite a big factor is the quality of sponsorship we have.	Responsibility falls heavily on the sponsor and leader of a project when it comes to working towards a successful project. They must be committed to seeing the project through to the end and doing everything they can to ensure the success of the project	Commitment
	"*Would you say over the time, I think Six Sigma was started here in 01/02, would you say that's been beneficial to the business?":* Yes definitely, the mana for a better word or credibility has started to increase…spent a lot of time battling to get people to use DMAIC... there has been a much higher call from management team for resources to come in and people to come help... Seeing it as how we go about our work, rather than it being additional....Where what we are trying to move to is not actually core to your role then it's the wrong project. It's not actually I've got this work to do and my Six Sigma project it's 'I've got this work to do and Six Sigma is how I go about doing that work".	Six Sigma has provided business benefits to the organisation People recognise how useful Six Sigma can be if implemented and used well, projects should relate directly to the workers regular duties and not seen as an extra project that pulls them away from regular duties	Business Benefits

	"well I think if we out them in a position where they have to use it when they come out of the training and practice the skills, then hopefully they get some of them leaving like 'I've done all this work, but my measure phase was inaccurate, now I can't tell if I've made a difference' would be a common one.... They are going to be stronger at the end of it because they have practiced it more frequently and they have been able to do it in sizes that are not too diverse and complex that we can never see if we get anywhere.	Taking the skills learnt in training and putting them to actually use on projects is an effective way of solidifying the knowledge the Green belts have learnt	Training
	"Yeah and we have put in a lot of effort into the belts, but in my opinion not enough effort into the sponsor… so it's supposed to be a pull system where they do the black belt and ask for help	Recognise the importance of having and providing assistance when it should be required. The Black belts and Senior management should be committed to ensure as many people Succeed in their projects and therefore gain certification for Green Belt.	Commitment Resource allocation (Assistance)
	"So have you found that there is now the motivation to get that project completed?": In the past few years we have linked certification to their salary. So if you want to get paid as well as you possibly can, you need to follow through with that certification work... So the current wave is a little bit disconnected, But as the year goes on , at the end of august they haven't been certified then that are starting to lose money out of their new pay increase...I personally think that what will drive the pressure at the end is that salary implication. You know EMPLOYEE charts the number of people being certified each year, when we did that we got an out of control point... my accountability to the Black belt team and business improvement team, and what we find is that people that get certified quicker are more receptive to the coaching, they are making progress faster and over all need less support from the business improvement team because they get through and done.	Motivation to complete projects/finish training and gain certification is now being generated by the power of money. This is possibly not the best motivator, but for the mean time it seems like it is working for the business. Projects seen as a chore or extra work, more pressure &responsibility on the trainees	Motivation (incentives)

	“There’s not point sitting on a dead horse and flogging it. So part of the measure phase is where you check and see if the data is correct… when we close a project. It's doesn't have to be at the measure phase, It could be just the companies priorities have changed. So yes that may morph into a different project and it's never looked at again, or it’s parked until some other condition is meet and it’s come back to.	Consistent with what other senior managers have said and a few project leads. If the project has become out of scope or is simply not progressing how it should there is no point wasting resources continuing with the project. We have seen examples of this from projects	
	"On site we there are about 700 different flavours of human beings. You and I are different. We are not the same... So people will have their own strengths and weaknesses, so in terms of projects we do a lot better if there was a different communication plan that people brought with them. You know R=Q*A. People are really good at Q but crap at A, if you do a brilliant solution but can’t get the A then you’re going to get great acceptance for a poor quality solution as well.... this might be done by teaming up with someone who is, or getting the right kind of support	R=Q*A mentioned again. This time from a different perspective. There is no use being good at 'A' but bad at 'Q'. Solution to this is teaming up with others that are good at what you are not.	Acceptance resource allocation
	"So quite often the difference between these rejects is where you’re able to bring the people with you. So that’s one of the things using DMAIC and traditional project where you have a team and that team is respective of a larger group and recognised as being, and respected within those groups, part of that is not just about getting some free lunches and workshops, part of that is about ensuring that project is being used when it goes out into the field... we are trying to influence a bigger group of people with many of these things."	Talking about bringing people together. It is beneficial if the group working on the project is respected and known for doing a good job.	Acceptance

	"If you want to make changes relatively quickly you're better off doing it as a workshop than trying the work yourself. So we would form a team that represents the stakeholders. So for a lot of your projects that means you'll have some operators, maybe a maintainer, some technical staff, or maybe someone from overseas....you may be asking questions like what causes this, root cause trees. All these tools that sit in Six Sigma and by getting the tram to engage with that and if they get to the end and don't feel ownership then they probably haven't been participating. It's pretty hard to disagree with yourself... Maci gives you processes but a big chunk of it is built in the relationships"	Participation leads to ownership and ultimately acceptance of the final project. Inclusion of certain people may have an effect on the success of the project	Acceptance
	"If you try and do that [Project] with one person by themselves that takes a long time and you've only persons set of ideas. Um if we bring a team together and they all bring their prospective together and hopefully we get there faster, And hopefully bring some people with us, a lot of our staff the only difference between our tertiary qualified engineers and our operators in a lot of cases is nothing to with what's sitting on top of their shoulders, it's about the opportunity that the staff that are usually a nit younger have had verses our baby boomers... You want the capability of the team to match the level of the problem... I'm not going to have four of our operators there squirreling away trying to work it either. I'm going to chuck some money at that"	Making the most of the resources at your disposal, or adding additional money or extra resources should the need arrive. Should be noted that this is the view of a senior manager not just a project member.	Resource allocation
	"There is a tendency here to 'boil the ocean' or 'eat the elephant' We scope a project as fix world hunger, so a project that's way too big. Way to complex, too many variables and we get those all the time, or not specified clearly, i.e. improve safety…. we can have the big save the world hunger aspiration, but that's not one project. That might be 20 projects, so the first we look at that and break it down, in the first project what I want you to solve is how to get a million a week out of the world's western population in donations. Then the second thing might be, ok now we've got that, that would go twice as far if we could get some tax breaks... yeah so projects go better if we can go from start to finish in a reasonable short time frame....so you're getting the bite sized chunks, meal sized bites that you can actually get through and consume, verses wheeling in an elephant for you to eat."	Interesting metaphor. Breaks down to ensuring that the scope of the project isn't too large and out of control. All this is determined in the Define phase. Could a big project be broken down into several smaller projects to minimise the risk of failure and increase efficiency?	Project structure (Define)

	"Thing about define I think is that I've personally found the hardest is finding a good primary metric… yeah so part of your define phase on what your primary metric is.	Once again define mentioned as being important. Narrowing down and understanding what the primary metric for the project is. Understanding the primary metric and being able to accurately measure when you have achieved it, is one definitive way of recognising the success of a project.	Project structure (Define)
	"well if, how I've mostly experienced that is the coaching being pushed onto you, I'm not the least bit interested in being coached so I'll just burn half an hour of our time while you tell me what you think, then I'm going to ignore it when you walk out. So think again it comes to that Q*A sort of thing. If there is no acceptance on my end if the quality is poor then we are not going to have a good outcome"	Possibility of the coaching or training being too over bearing. This would be a negative effect of a high commitment level that a Black Belt might have, as they are under pressure to ensure their Green Belts pass their projects.	Commitment
	"You've got a formal relationship with coach, we do also run during the training phase these public gate reviews. So that's where we get a selection of the Belts come and present their project…where is someone stands up the front, in front of the GM [general manager], their manager, superintendent, their peer group, you don't want them walking away feeling embarrassed because everyone else is going so see that as well and how many volunteers are we going to get next time?... They started out voluntary because we were getting enough. We've had some problems with it and now it's been made far more compulsory and we've scheduled who's going to get up and speak."	These gate reviews shows the commitment of everyone at the organisation. Very well be part of the control phase except it happens on a six monthly rotation, so throughout a projects life cycle.	Commitment

	“I occasionally take phone calls from recruiting agencies saying 'oh EMPLOYEE, have we got the job offer for you' kind of thing. I've done a decade as an engineer, I'm a chartered professional engineer, and I've done all these professional roles. Most of the phone calls I get, the only thing people are asking about is my Business improvement experience. So the Black Belt role title is very, it could come and go over time, But it is something that seems to be valued outside of the industry"	Provides more evidence that Six Sigma is an extremely sought after skill set. Additionally strengthens that finding from the literature review that there is a demand for Six Sigma trained professionals in New Zealand	Six Sigma skills are in demand in New Zealand.

Interview 10

Interview 10			
Project	**Quote**	**Thoughts/coding**	**Group/Category**
10	This is high purity PRODUCT. When this comes in, it comes with a certificate of analysis, and that's usually three decimal places for PRODUCT. So it either tends to come in at 006 or 007 iron contamination…Because a 006 shipment could mean that it's 0056 or 0064.... So we decided to see if we could improve the measurement system in PRODUCT so we could get a better understanding of how much iron was in the PRODUCT.	Project was focused around creating a more accurate measurement system. In this case one that would allow the business to gain a better understanding of the iron level in the product.	Project Background
	"Being able to understand how to make it properly [Product] and to predict whether we can. This was one of the projects to identify the impact of how much the raw materials were having so that we can them, if the raw materials is not the issue, then we can look at the process as the cause. But if we don't understand how much contamination is coming in from raw materials then we don't know where to look and it's very easy to say raw materials...So it's about separating, well we know what the raw material input of the PRODUCT should be, and if it's over and above that then there is process inputs in the PRODUCT... so we know how much is coming in on the raw materials so we know how much impact that process is having and we can do some work on the process."	Driving factor: Process improvement By understanding the exact make-up of the raw materials, they can then disregard the raw materials as an factor when there is an issue and focus investigation elsewhere.	Driving factor: Process improvement
	"It was a high benefit, reasonable low effort…. 100% time commitment."	This project chosen as it was favourably within the effort/benefit matrix. Meaning that this project had a high benefit for the organisation with a relatively low effort. Also the interview spent 100% of their time on this single project.	Project Background
	"Well yes, we did the measure phase that required a bit of input from them [labs], and understanding the standard deviation and measurement error of systems as well.	High number of people involved with this project	Project background

	"Was it successful because it met all of its objectives?": Yes it did that, but also it provides us with a lot more clarity, so before this we used, the results of the PRODUCT samples used to go 005,006,007 etc... But now we can actually see the variation within each measurement on a daily sample.	Project successful as it met the objectives set at the Define phase. Provides positive value and benefit towards the business.	Project successful
	"What would you say went well with the project?": I think people understood what we were trying to achieve, so we had a good opportunity statement, it met the business benefits that we were looking for and we had the buy in from the people that were making the changes....So they understood and were happy to do the work because they understood the benefit it would provide to BUSINESS.... EMPLOYEE would have said this before. The results you get from any project is the quality of the solution.	Project went well because everyone involved recognised the important and value of it This lead to increased buy in and acceptance of those involved.	Acceptance
	"Well I guess EMPLOYEE [knowledge/experience] was pivotal because she had to know the systems they were using and provide me with the measurement system errors for each of the steps in the process so we could actually understand if we are getting a 4th decimal, what is the measurement error of the 4th decimal place? Because there is no point doing it if it's a 3rd decimal place	Involved the employee that follows the process regularly as they have the experience and knowledge regarding the systems.	Knowledge
	"*How important was the initial scope/charter?":* That's always important because if you don't have the scope right, then you might be working on a problem that the site doesn't want solved. You have to define the problem you want to solve and get everyone's agreement. Just have a conversation, saying this is what I want you to do. If you don't come back with a define stage you could actually be misunderstanding it.	Further evidence to support the claims the Define phase of DMAIC is incredibly important. Provides the opportunity to properly understand the issue on hand, by understanding what is in and out of scope	Project structure (define)
	"There were some questions around the processes, but we got that resolved during the measurement phase….We were very confident because we broke each step down into what the measurement error was for each step in the process.....That was based on, we did a number of tests for each of the steps and from that you get the standard deviation and can calculate the measurement systems. So it was very methodological.	Measurement phase was very methodological. Each of steps was broken down into the measurement error to understand how accurate the measurement systems were.	Measurement

	"That's what makes a business improvement team really valuable because you can dedicate 100% of your time to getting it completed….. So every trainee Green Belt gets assigned a Black Belt coach, to assist them if they had any issues, their first point of contact and also when they are running though, getting prepared for a gate review you run that through with the business improvement coach and make sure they have everything covered off. So the likelihood of success for each phase is higher."	Dedicated business improvement team can be beneficial as they have the ability to be full commit (100%) of their time to a single project Provides support to the Green Belts throughout the duration of their project life cycle.	Commitment
	[training] EMPLOYEE basically leads it, with Black Belts taking modules. So I've taken a couple of modules during my training, The next Green Belt I think is going to be in Brisbane and I'm not sure who will be taking that.	The business can do their own independent training for Green and Black belts on site due to the fact they have a Master Black Belt at their disposal.	Training
	"And they [employees] end up solving a problem you weren't actually looking for... And moment when you do the measure phase you realise the problem isn't the problem you though it was, it's a measurement issue… essentially because the project isn't there because how we are doing the measurement is the perceived problem	Measurement accuracy extremely important. The problem that the project is testing for may not be a real issue, but simply the result of an inaccurate measurement system	Measurement
	"I've had a project killed that was killed at the improve phase, so we know what we need to do, We are just not going to do it right now.	Further evidence that projects can be killed off at any stage of the DMAIC process because it has drifted out of scope or the business priorities have changed. This shows the importance of the Define stage and understand the scope of the project	Project structure (define)

	"So what is the definition of a successful project?": That is the easiest definition. A successful project is one where 12 months after your gate review, you do a verify gate review and the improvements are still in place and getting the results you anticipated	Interesting definition. Different to what others have mentioned. A successful project is categorised not only as meeting the objectives but continuing to after a 12 month period.	Project success definition
	"The difficulty with some of the Green Belt trainees is that some of them see their project as an addition to their role rather than a part of their role. So when they start seeing that as an addition to their role rather than tools to get their job done, then often the progress on their project slows, as their day to day workload is so high.	Another claim that the projects need to align with a person's regular work role or even invested interested. Something that they feel investing effort in so they feel more pressure to complete successfully.	Training
	"You really have to get the team involved right from the start, so they have that acceptance. Otherwise it will fail even if it's the best solution in the world.	Acceptance of the project begins right at the beginning. Involving people early on so there interest and investment of effort grows as the project progresses. Additionally another mention of having the best solution but low acceptance is useless.	Acceptance
11	"We identified the primary root cause in DEPARTMENT lines. EMPLOYEE did a whole bunch of work in DEPARTMENT rectifying and installing PRODUCT to remove the iron in PRODUCT [raw material].	Project driver: quality. Increasing the quality of the raw materials will have a positive effect on the quality of the final product	Project driver : Quality Process improvement
	"Now it's running properly and the drop in iron in PRODUCT [raw material] from maybe 450 ppm to 250 ppm…. The manager at the time… said you will never get it below 400.	Successful project. Passed objectives and surpassed what others thought was impossible	Project successful

	"It just goes to show that Six Sigma does work, going through a systematic process"	Interviewee's belief that Six Sigma is beneficial and does work when followed through all the steps in a systematic way. Project structure is important as the project must work through all phases of DMAIC systematically	Benefit of Six Sigma Project structure

Appendix 3. Commitment Rating

Pre-Launch Commitment Rating Checklist

To be completed with Manager BI & project Sponsor prior to project Launch.

Fill in the blue cells

	HSE	Financial Gain	Combination of HSE & Financial %	
1 What is the main motivational drive behind this project? (enter as a %, the combination to equal 100)	20	80	100	Correct Total

Please enter the score that best fits your current belief in the blue column, using the grid below.

		WEIGHT		Enter a score 1 to 10	1	2	3	4	5	6	7	8	9	10
2	Is there a HSE benefit	2%	=	6	Don't Know	No HSE benefit		Little HSE benefit		Some HSE benefit		**Enabler** or significant HSE benefit		Serious HSE risk will be eliminated
3	What is the potential financial benefit of the project?	8%	=	5	Don't Know	Less than $30k	$31k - $50k	$51k - $90k	$91k - $150k	$151k - $200k	$201k - $250k	**Enabler** or $251k - $300k,	$301k - $400k	Over $400k
4	What is the sponsors level of pain as a result of this problem?	25%	=	8	Don't Know	No pain		Niggle		Minor pain		Steady pain		Acute Pain
5	Is it clear exactly how project success will be measured?	10%	=	5	No measures defined	Only general text	Subjective measures only	One potential numeric measure identified	Several potential numeric measures identified	Numeric measures identified (with units)	Numeric measures, but no targets specified	One numeric target specified	Several numeric targets specified	Crystal clear all numeric targets specified
6	Confidence that the BB is determined to bring the project to a successful conclusion?	5%	=	8	No confidence	No Idea	30% confident	40% confident	50% confident	60% confident	70% confident	80% confident	90% confident	No doubt of success
7	Is the process to be improved stable?	10%	=	9	Chaotic process no data available	Chaotic process with limited data available	Chaotic process good data available	Unstable process with no data available	Unstable process limited data available	Unstable process with good data available	Recently modified process	Stable process with no data available	Stable process with limited data available	Stable process with good data available
8	How stable is the organisation within the area(s) implicated in this project?	10%	=	8	Don't Know	Constant state of flux		Unstable		Pretty Stable		Very Stable		Extremely stable
9	What is the sponsors knowledge and understanding of the process to be improved?	5%	=	8	No Process Knowledge	Very limited process knowledge		Limited Process Knowledge		Basic Understanding of Process		Good process knowledge		Process Expert
10	Does the sponsor know the historical background to this project?	5%		8	No knowledge	Very limited background knowledge		Limited background knowledge		Basic understanding of background		Detailed background knowledge		Intimate knowledge of background
11	Does the sponsor have the resources to be tackling this project at this time?	15%	=	8	No resources at all	No resources available	Some resource available but very limited time & money	Some resource available but limited time & money	Able to commit 30% of expected resource required	Able to commit 50% of expected resource required	Able to commit 80% of expected resource required	Able to commit 100% of expected resource required	Able to commit more than expected resource required	Ability to fully commit whatever resource required
12	Is there a potential for "quick wins"?	5%	=	6	No potential	Very low probability of quick win	Limited chance one quick win	Limited chance of some quick wins	Some potential for quick wins	Good possibility of a quick win	Excellent possibility of quick win	One obvious quick win	Two obvious quick wins	Many obvious quick wins

Total Score = **74** Out of a potential 100 Points

Score 90 to 100 Highly Confident to Proceed
80 to 89 Confident to proceed
70 to 79 Will need to be monitored closely & will need active sponsor support/involvement
60 to 69 Concern! Will need Active coaching support from MBB/Manager BI
50 to 59 Danger! Needs further discussion before launching
Less than 50 Stop! Do not start as defined

Completed By: _____ Manager BI

_____ Sponsor

_____ Date

Appendix 4. Gate Review Checklist

Define

Define gate review

Project:		Date Completed:	Gate Review Status:
Project			On Plan
Project Leader:	**Project Sponsor:**	**Authorised By:**	**Form Status:**
soneill			ok

Summary

Has the Define gate review has been passed? ○ Yes ◉ No

Attendees

Name	Role	Attended	Comments
soneill	Project Leader	☐	

Standard Checklist (choose either DMAIC or DMADV)

Complete each item on the checklist for the Define gate review

- ☐ 1. Does the project support the general strategy?
- ☐ 2. Are the assumptions used for selection still valid?
- ☐ 3. Problem statement contains – when, what, magnitude, impact or consequence?
- ☐ 4. Defines the results expected to be achieved, with SMART targets?
- ☐ 5. Is the project scope reasonable?
- ☐ 6. Customer requirements defined and measurable.
- ☐ 7. Right resources on the team?
- ☐ 8. Key stakeholders identified, involved, contacted?
- ☐ 9. Have best practices identified and incorporated?
- ☐ 10. High level project plan with key milestones?
- ☐ 11. Barriers/obstacles identified and planned for?
- ☐ 12. What HSE activities have taken place?

DMADV

Actions to be completed

List items that are specific to this event.

Item No.	Action

Summary

Enter comments/notes or summary below.

Measure

Measure gate review

Project:		Date Completed:	Gate Review Status:
Project			On Plan
Project Leader:	**Project Sponsor:**	**Authorised By:**	**Form Status:**
soneill			ok

Summary

Has the Measure gate review has been passed? ○ Yes ◉ No

Attendees

Name	Role	Attended	Comments
soneill	Project Leader	☐	

Standard Checklist (choose either DMAIC or DMADV)

Complete each item on the checklist for the Measure gate review

- ☐ 1. Value Stream Map been completed?
- ☐ 2. Identified the specific input (x), process (x), and output (y) measures?
- ☐ 3. Measurement system checked?
- ☐ 4. Developed clear, unambiguous operational definitions for each measurement?
- ☐ 5. Gathering new data or taking advantage of existing data?
- ☐ 6. Stratification factors identified?
- ☐ 7. Developed and tested data collection forms or check sheets?
- ☐ 8. Sample size and frequency established?
- ☐ 9. Baseline performance and process capability established?

DMADV

Actions to be completed

List items that are specific to this event.

Item No.	Action

Summary

Enter comments/notes or summary below.

Analyse

Analyse gate review

Project:		Date Completed:	Gate Review Status:
Project			On Plan
Project Leader:	**Project Sponsor:**	**Authorised By:**	**Form Status:**
soneill			ok

Summary

Has the Analyse gate review has been passed? ○ Yes ◉ No

Attendees

Name	Role	Attended	Comments
soneill	Project Leader	☐	

Standard Checklist (choose either DMAIC or DMADV)

Complete each item on the checklist for the Analyse gate review

- ☐ 1. Examined the process and identified potential bottlenecks, disconnects and redundancies?
- ☐ 2. Conducted a value-added and cycle time analysis?
- ☐ 3. Analysed data about the process and its performance?
- ☐ 4. Identified reasons for variation and generate hypothesis as to root causes?
- ☐ 5. Determine if problem can be solved without a fundamental changes?
- ☐ 6. Decision confirmed with the process owner?
- ☐ 7. Investigated and validated (or devalidated) the root cause hypotheses?
- ☐ 8. Understand why the problem is being seen?
- ☐ 9. HSE Management of Change tools used?

DMADV

Actions to be completed

List items that are specific to this event.

Item No.	Action

Summary

Enter comments/notes or summary below.

Improve

Improve gate review

Project:		Date Completed:	Gate Review Status:
Project Leader:	**Project Sponsor:**	**Authorised By:**	**Form Status:**
	Champion		

Summary

Has the Improve/Design gate review has been passed?	

Attendees

Name	Role	Attended	Comments
		☐	

Standard Checklist (choose either DMAIC or DMADV)

Complete each item on the checklist for the Improve gate review

☐	1.	Techniques used to generate ideas for potential solutions?
☐	2.	Narrowing and screening techniques used?
☐	3.	Evaluation criteria used to select solution?
☐	4.	Proposed solutions address all of the identified root causes?
☐	5.	Solutions verified with the project sponsor and stakeholders? Approval received to implement?
☐	6.	Pilot run to test the solution? What was learned? What modifications were made?
☐	7.	HSE changes around implementation?
☐	8.	Evidence that the root causes have been addressed? Expected benefits?
☐	9.	Potential problems (FMEA) of the solution and preventive/contingency actions?
☐	10.	Proposed solution documented?
☐	11.	Implementation plan and status?
☐	12.	Changes communicated?
☐	13.	Training for process owners/operators performed?
☐	14.	HSE Management of Change plan?

DMAIC

Complete each item on the checklist for the Design gate review

☐	1.	Were detailed design elements generated?
☐	2.	Were Transfer Functions established?
☐	3.	Was the scorecard created/updated?
☐	4.	Were tolerances established for the critical design characteristics?
☐	5.	Were product characteristics translated to process characteristics?
☐	6.	Was the detailed process map developped?
☐	7.	Was a Risk Analysis performed on the detailed design?
☐	8.	Was Capability assessed and optimised?
☐	9.	Was a Pilot plan developed?
☐	10.	Has the preliminary product/process documentation been started? (Communication plan, SOP's, training...)
☐	11.	Was the project plan adjusted?
☐	12.	Have you refined the Project Charter from the Analyse Phase?

DMADV

Actions to be completed

List items that are specific to this event.

Control

Control gate review

Project:		Date Completed:	Gate Review Status:
Project			On Plan
Project Leader:	**Project Sponsor:**	**Authorised By:**	**Form Status:**
soneill			ok

Summary

Has the Control/Verify gate review has been passed? ○ Yes ◉ No

Attendees

Name	Role	Attended	Comments
soneill	Project Leader	☐	

Standard Checklist (choose either DMAIC or DMADV)

Complete each item on the checklist for the Control gate review

- ☐ 1. All essential documentation of the improved process complete?
- ☐ 2. Right measures selected to monitor performance?
- ☐ 3. Is the measurement simple?
- ☐ 4. Who owns the measures? What happens if minimum performance is not achieved?
- ☐ 5. Solution effectively implemented? Data confirms the solution achieved the goals?
- ☐ 6. HSE Management of Change considerations are a part of the Control Plan?
- ☐ 7. HSE changes around implementation?
- ☐ 8. What are the realized gains?
- ☐ 9. HSE professionals evaluated and signed off on the changes?
- ☐ 10. Process owner responsible for managing continuing operations?
- ☐ 11. Documentation for the tracking System developed? "Lessons learned" captured?
- ☐ 12. Other issues/opportunities identified as potential projects with brief charters?
- ☐ 13. Replication opportunities identified and communicated?
- ☐ 14. Successful efforts of team celebrated?

DMADV

Actions to be completed

List items that are specific to this event.

Item No.	Action

Summary

Enter comments/notes or summary below.